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Tadomi

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(54) **IMAGE HEATING APPARATUS**

(71) Applicant: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(72) Inventor: **Takuma Tadomi**, Toride (JP)

(73) Assignee: **Canon Kabushiki Kaisha**, Tokyo (JP)

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CPC ***G03G 15/2053*** (2013.01); ***G03G 15/2025*** (2013.01); ***G03G 15/2075*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/2053; G03G 15/2025; G03G 15/2075
USPC 399/327, 347; 219/216
See application file for complete search history.

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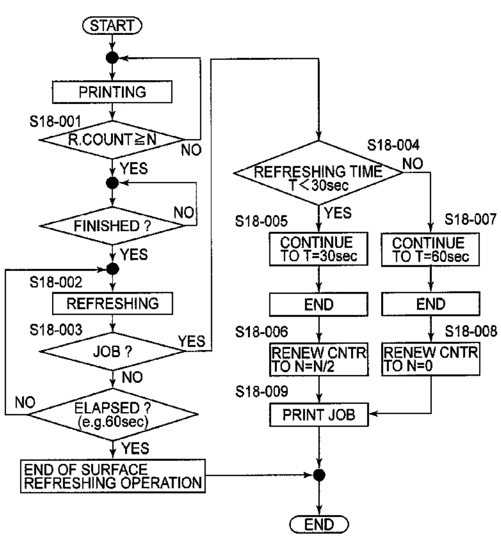
Primary Examiner — Robert Beatty
(74) *Attorney, Agent, or Firm* — Fitzpatrick, Cella, Harper & Scinto

(57) **ABSTRACT**

An image heating apparatus includes first and second rollers forming a nip therebetween to heat a toner image on a sheet; a rubbing roller for rubbing an outer surface of said first roller; a moving mechanism for moving said rubbing roller between a contact position for contacting with said first roller and a spacing position spaced from said first roller; a measuring portion for measuring time elapsed from start of a rubbing process; a controller for discriminating, upon receipt of image heating instructions during the rubbing process execution, whether to continue the rubbing process or to interrupt the rubbing process and execute the image heating process, on the basis of the time measured by said measuring portion.

10 Claims, 15 Drawing Sheets



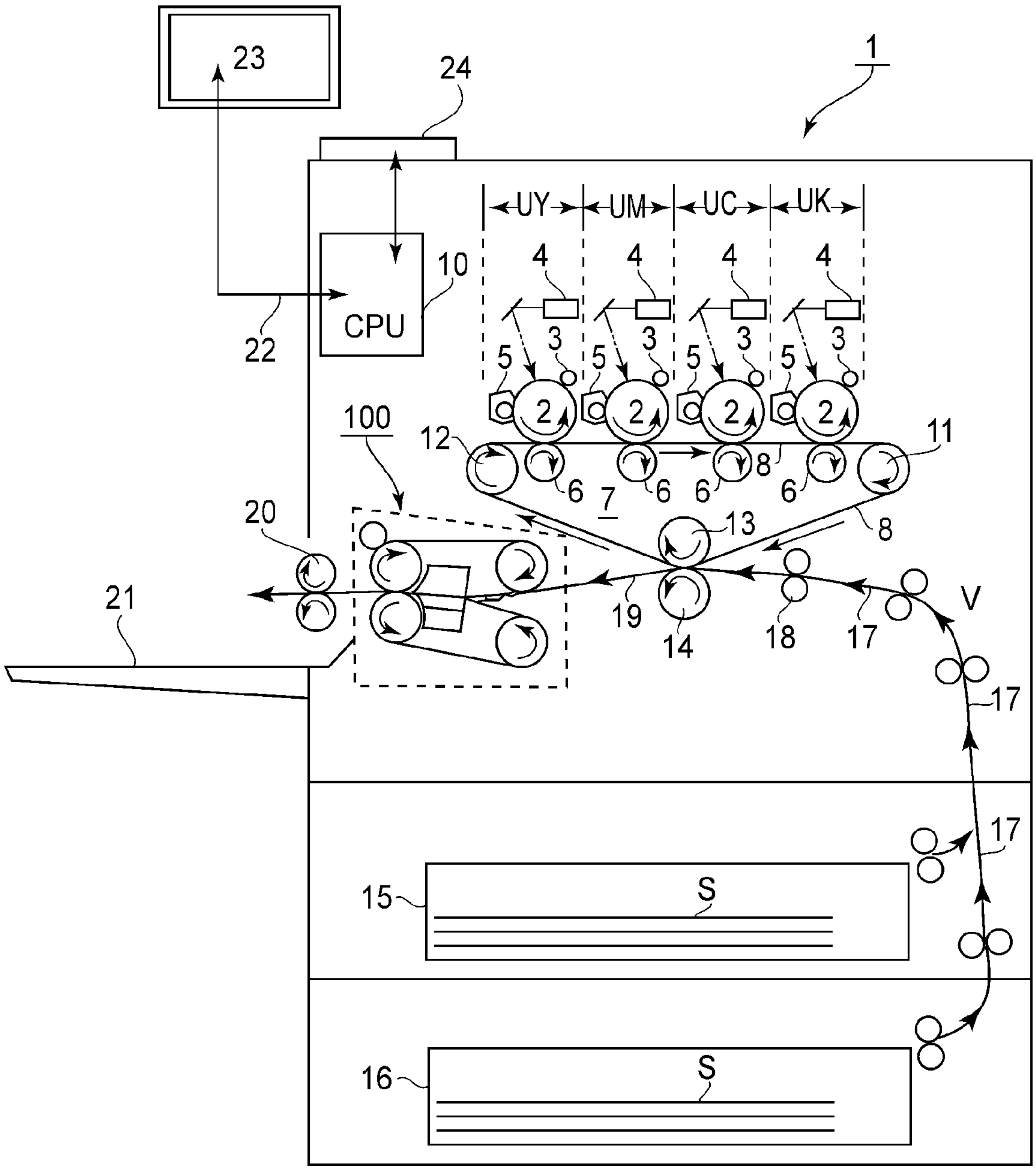

23
24
1
UY
UM
UC
UK
4
10
CPU
22
3
5
2
100
12
11
6
7
8
20
13
21
19
14
18
17
V
15
S
16

FIG. 1

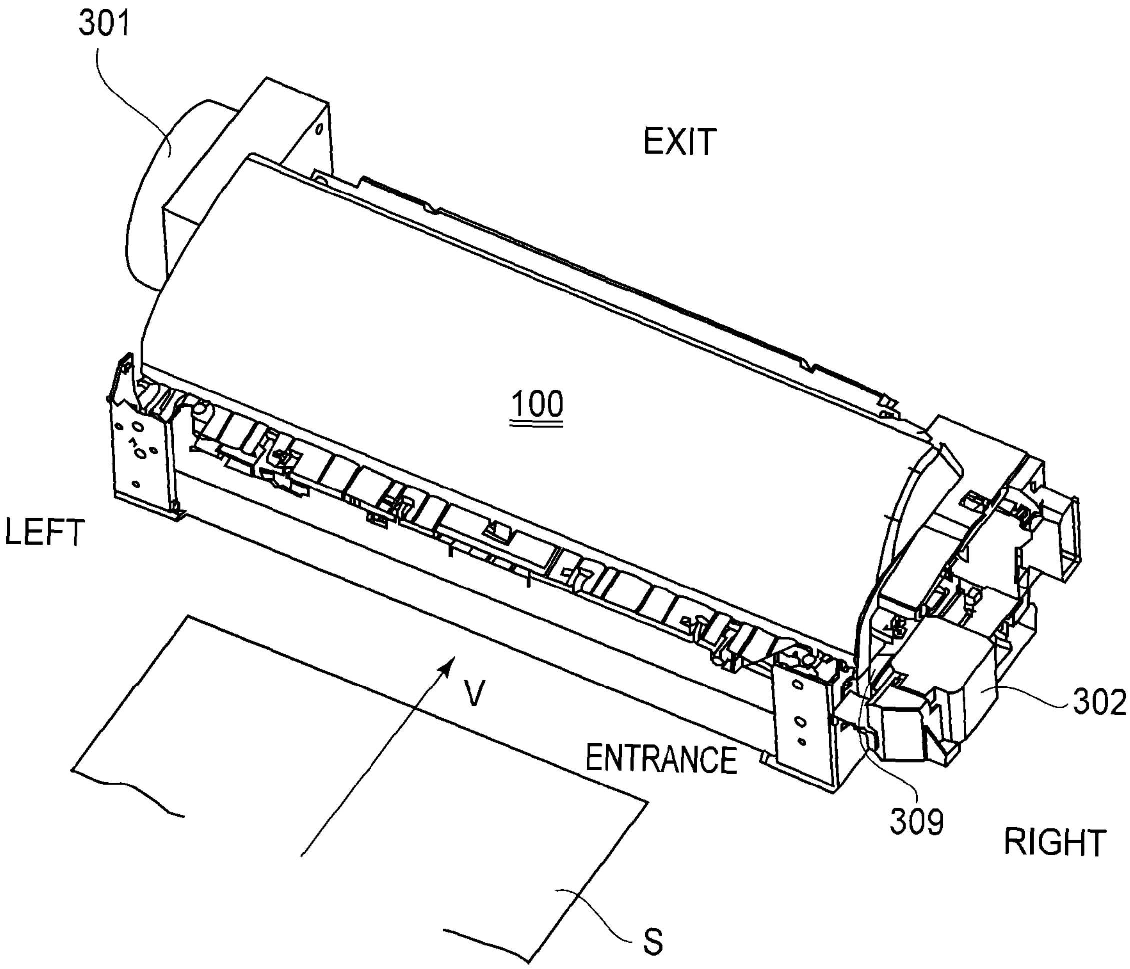


FIG.2

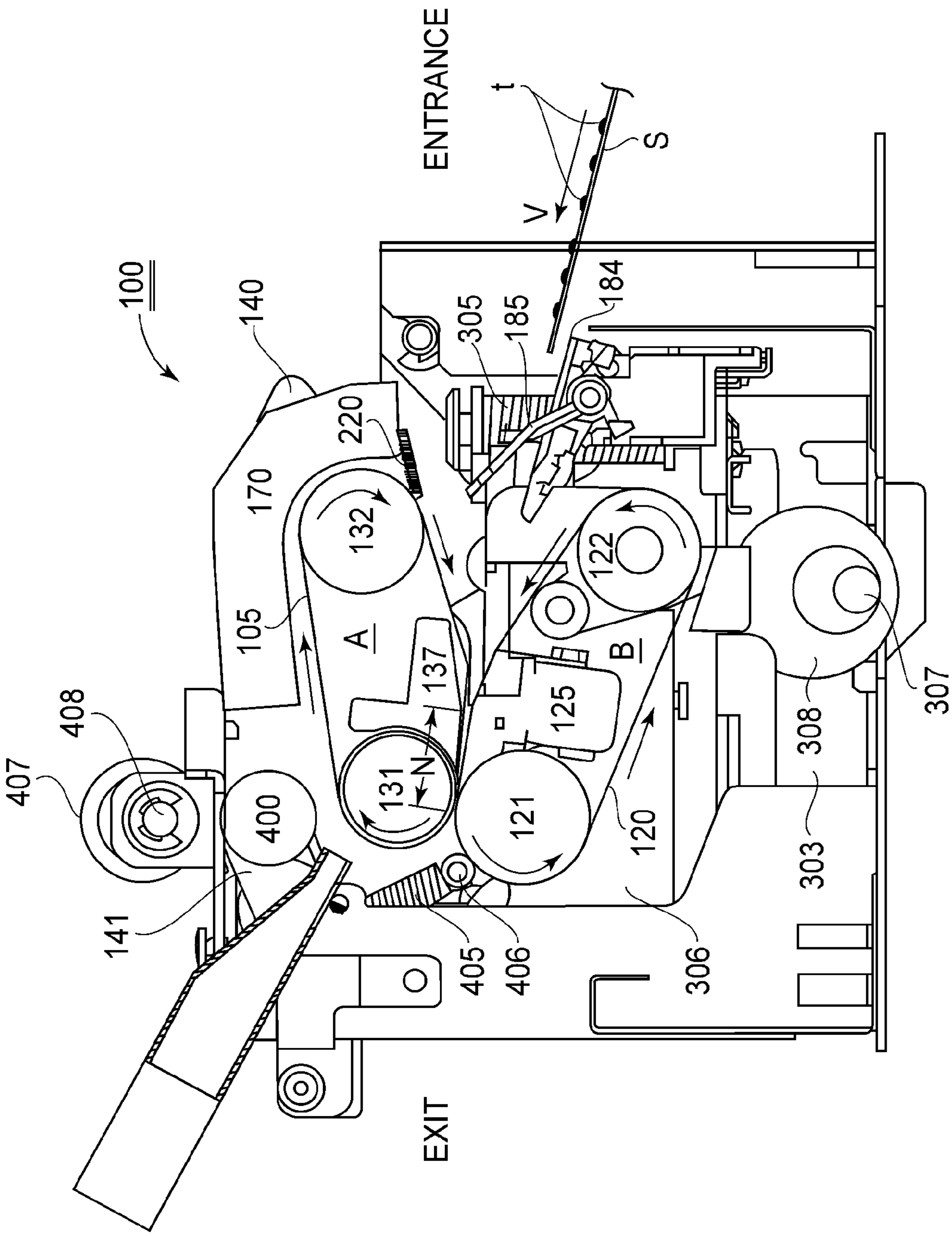

ENTRANCE
EXIT
100
140
170
220
105
A
137
131
N
132
B
125
122
121
120
400
407
408
141
405
406
306
303
308
307
305
185
184
V
t
S

FIG. 3

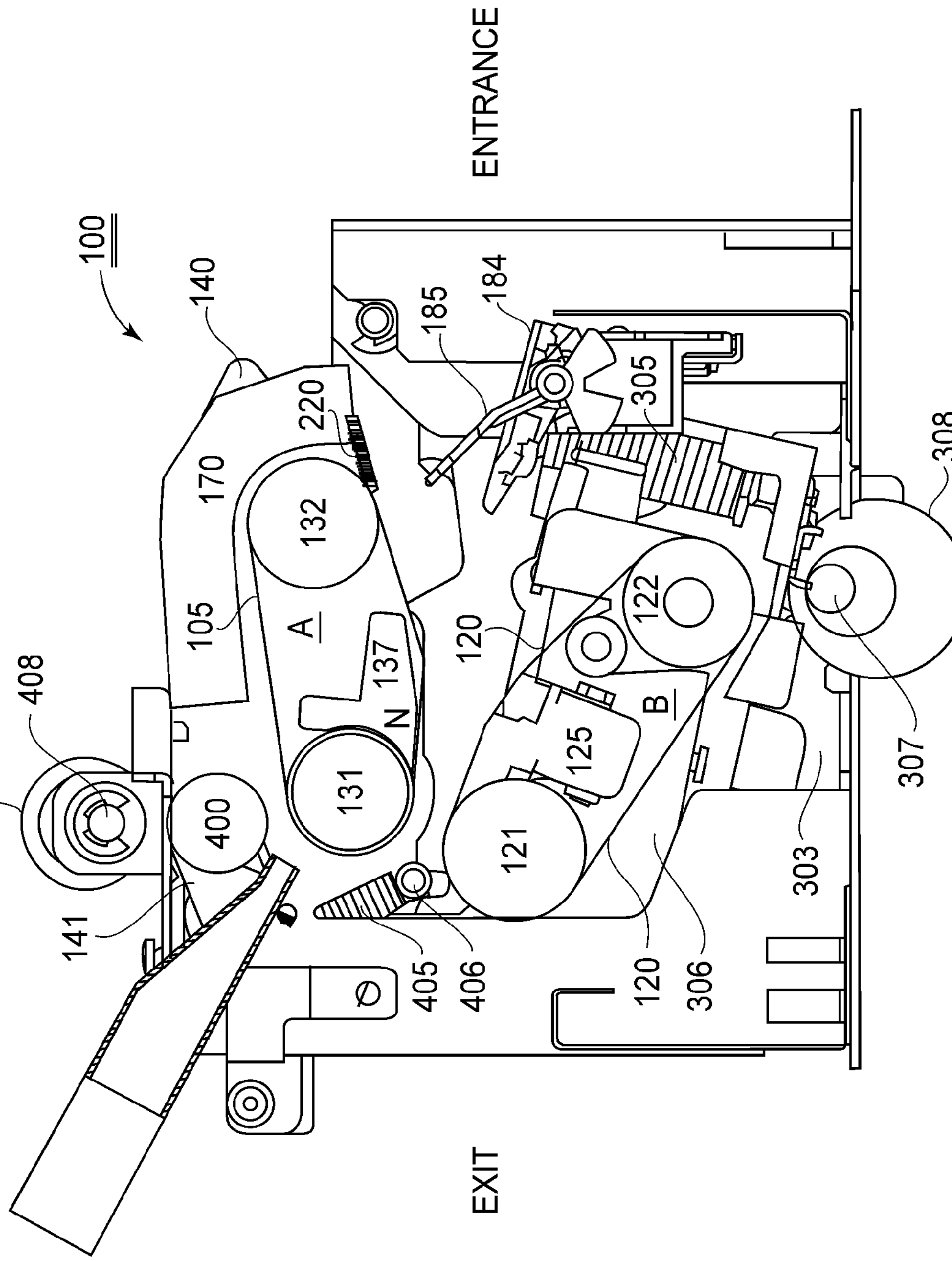
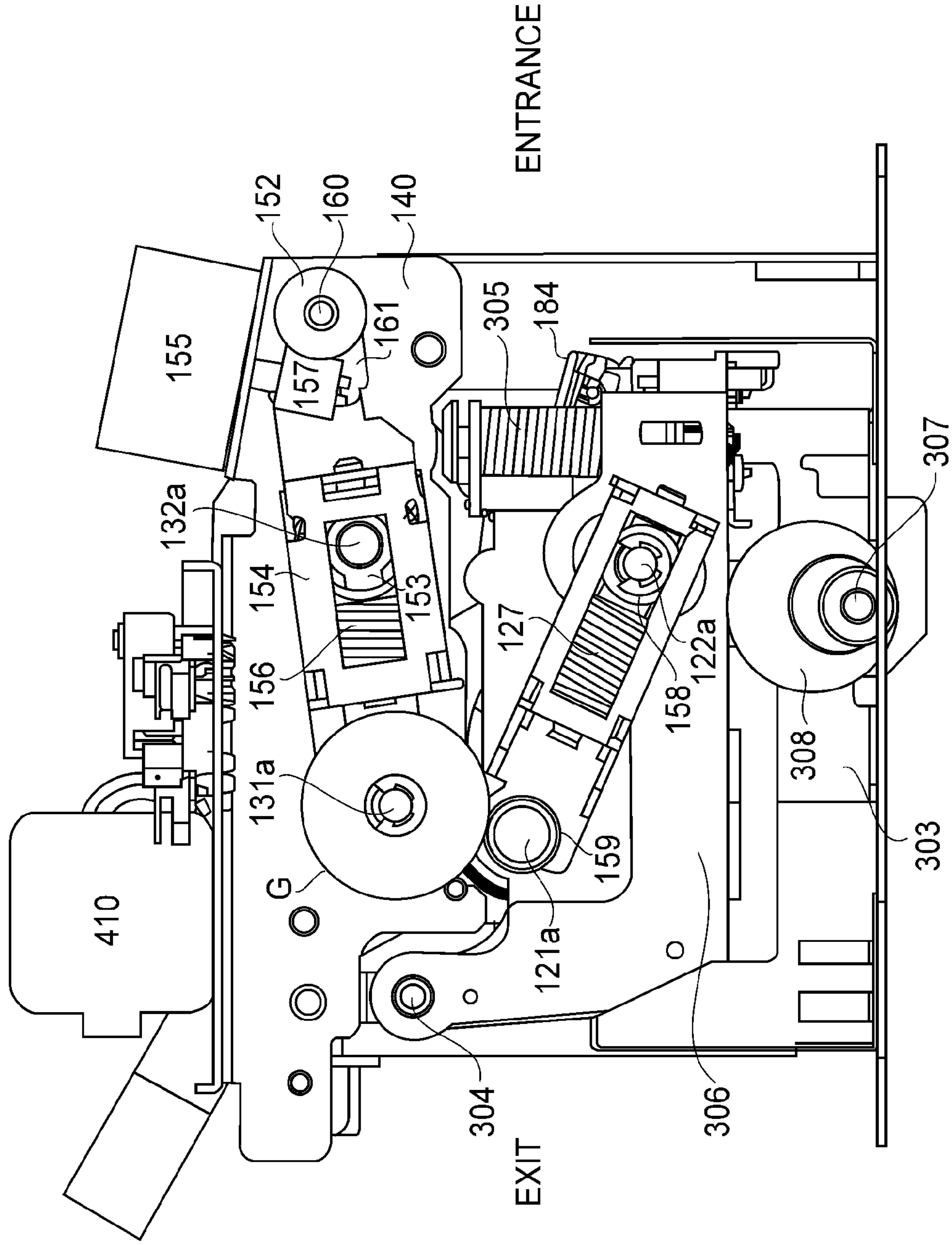

ENTRANCE
EXIT
100
140
170
220
105
132
A
137
N
131
400
407
408
141
405
406
121
120
125
B
122
306
303
305
184
185
308
307

FIG. 4



ENTRANCE
EXIT
152
160
140
155
157
161
305
184
307
132a
154
153
156
127
122a
158
308
131a
159
121a
G
410
303
304
306

FIG.5

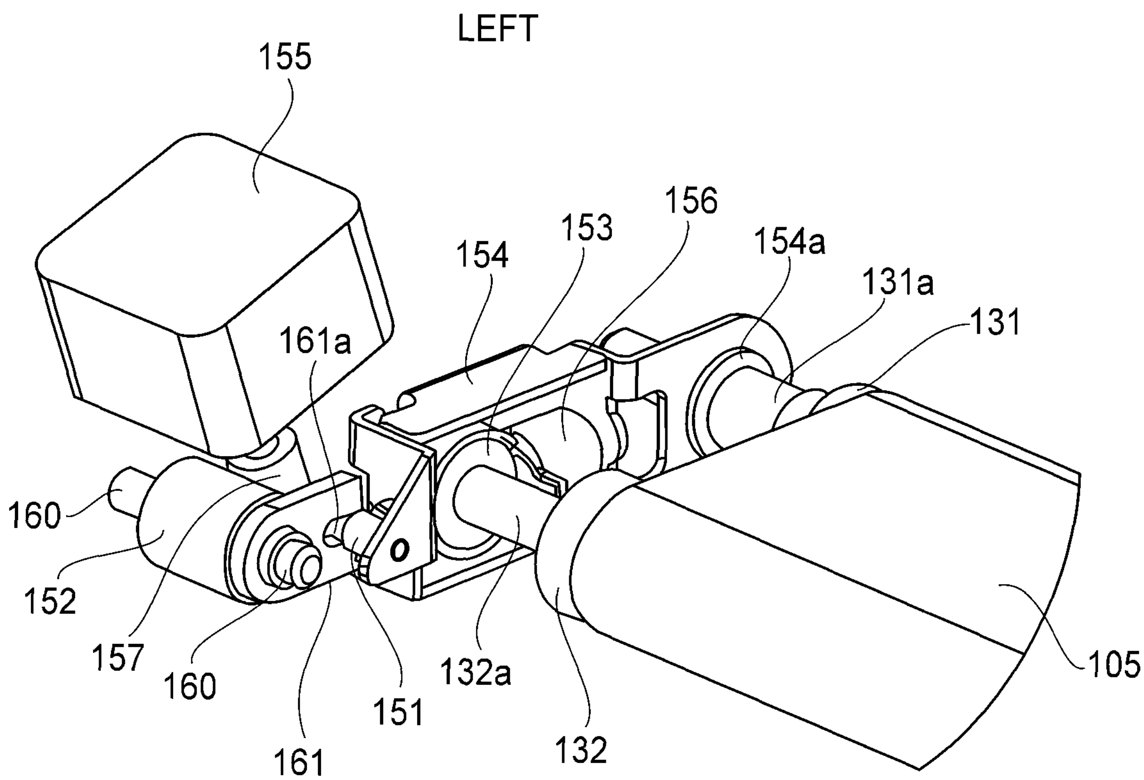

LEFT
155
154
153
156
154a
131a
131
161a
160
152
157
160
161
151
132a
132
105

FIG.6

FIG. 7A

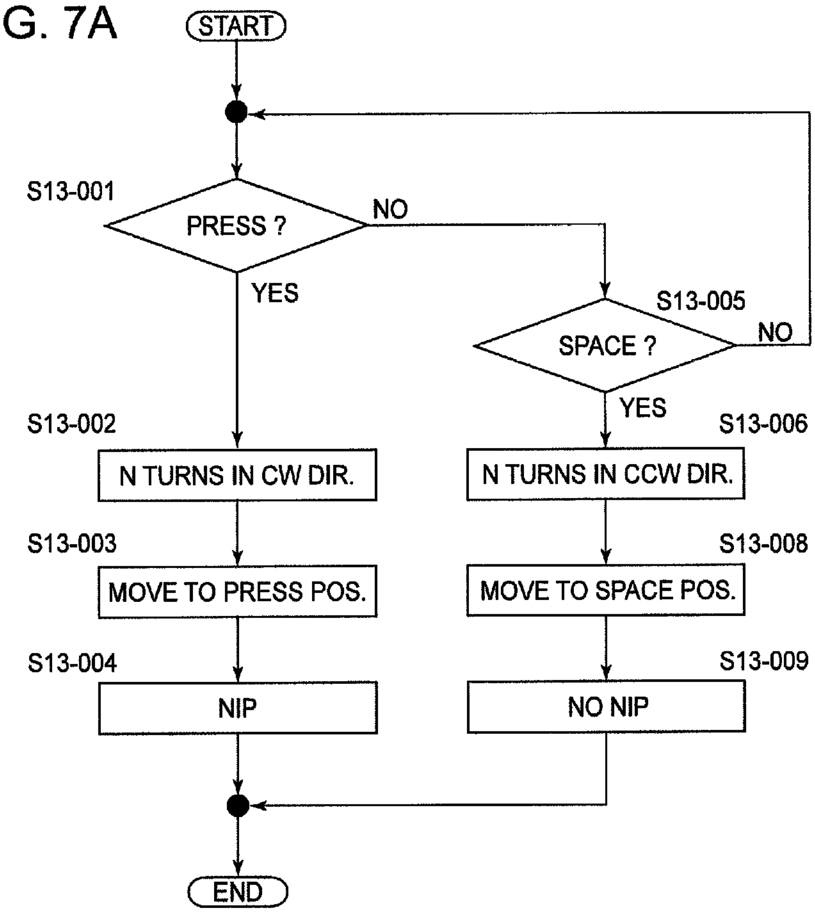

START
S13-001
PRESS ?
NO
YES
S13-005
SPACE ?
NO
YES
S13-002
N TURNS IN CW DIR.
S13-006
N TURNS IN CCW DIR.
S13-003
MOVE TO PRESS POS.
S13-008
MOVE TO SPACE POS.
S13-004
NIP
S13-009
NO NIP
END

FIG. 7B


CPU10
MTR DRVR 302D
PRESS. MTR 302

FIG. 8A

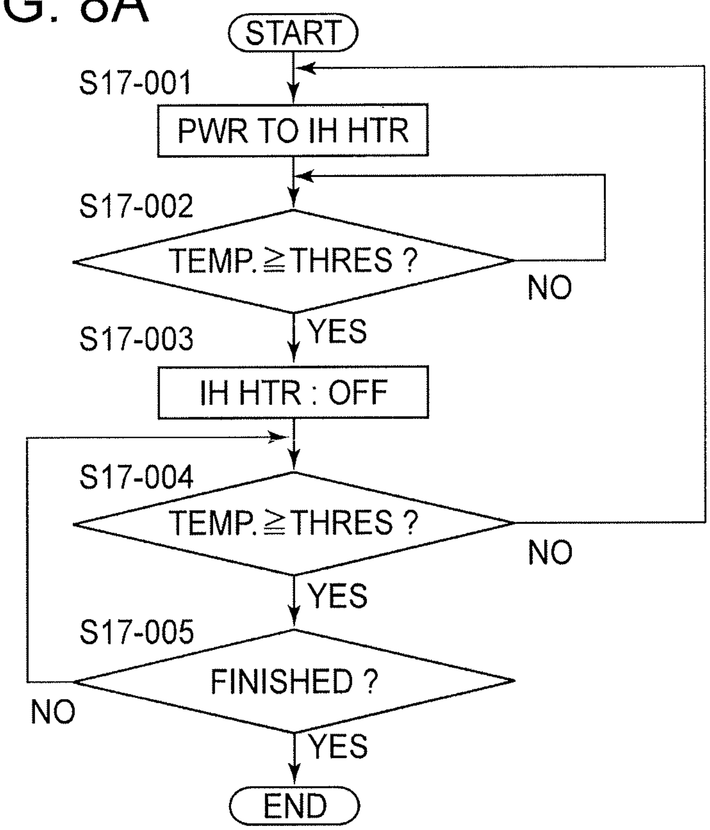

START
S17-001
PWR TO IH HTR
S17-002
TEMP.≧THRES ?
NO
YES
S17-003
IH HTR : OFF
S17-004
TEMP.≧THRES ?
NO
YES
S17-005
FINISHED ?
NO
YES
END

FIG. 8B

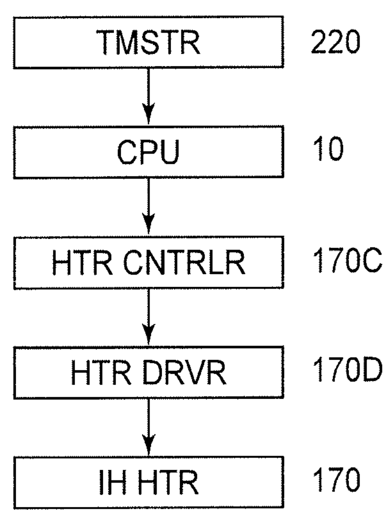

TMSTR
220
CPU
10
HTR CNTRLR
170C
HTR DRVR
170D
IH HTR
170

FIG. 9A

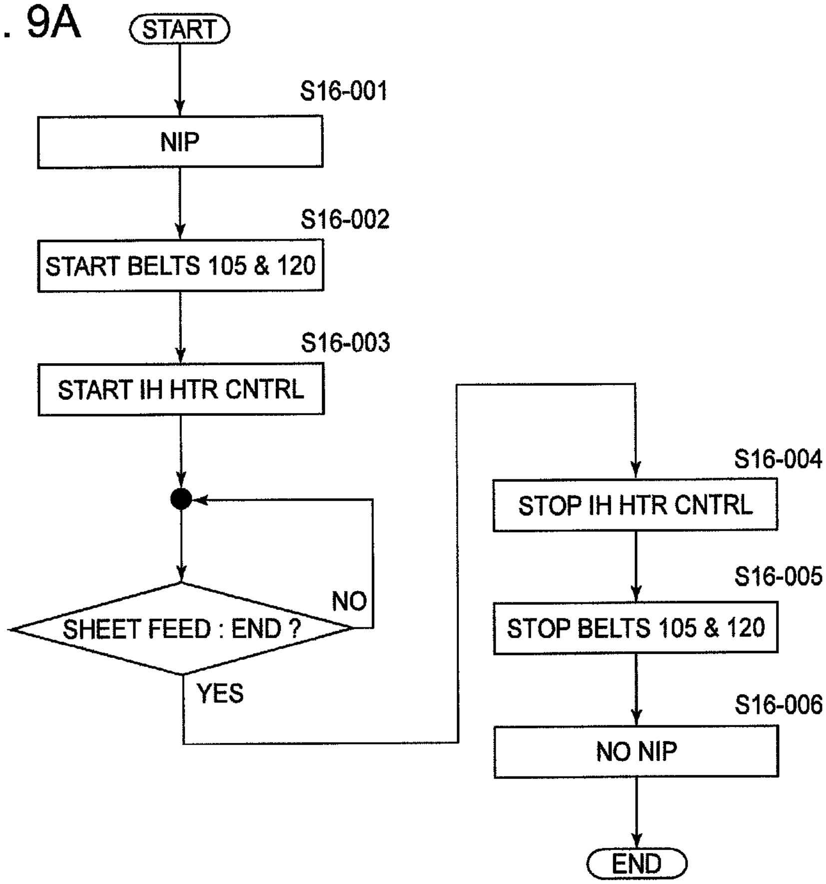

START
S16-001
NIP
S16-002
START BELTS 105 & 120
S16-003
START IH HTR CNTRL
SHEET FEED : END ?
NO
YES
S16-004
STOP IH HTR CNTRL
S16-005
STOP BELTS 105 & 120
S16-006
NO NIP
END

FIG. 9B


CPU10
MTR DRVR 301D
MTR 301

FIG. 10A

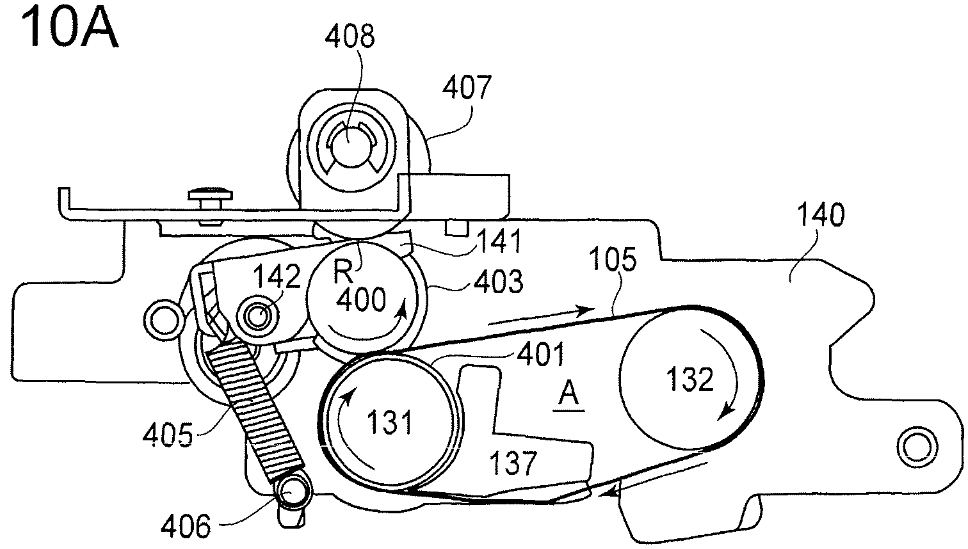


FIG. 10B

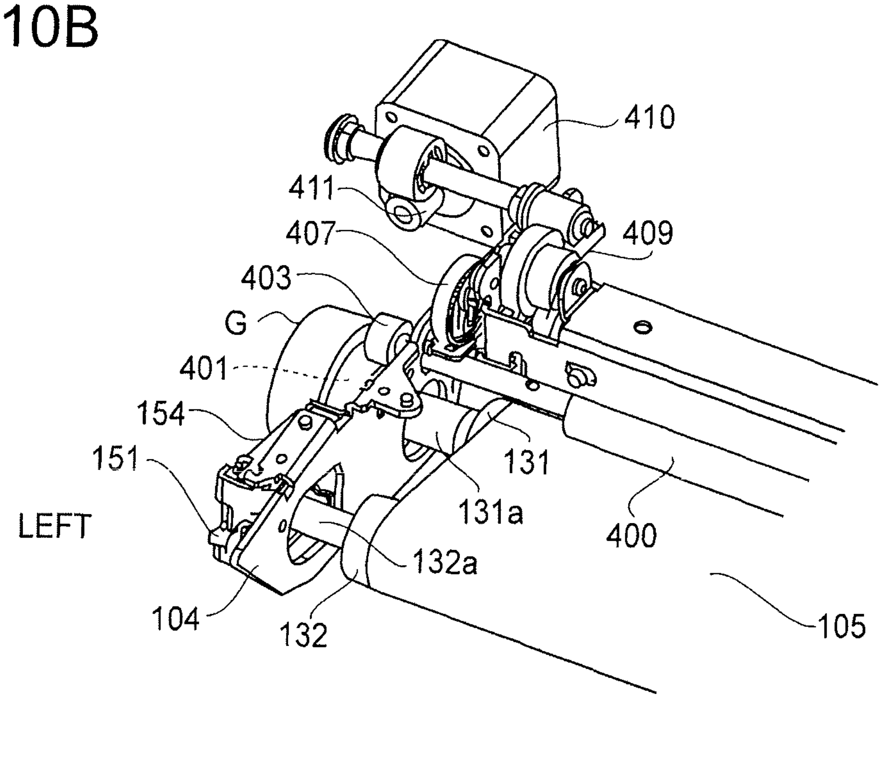


FIG. 11A

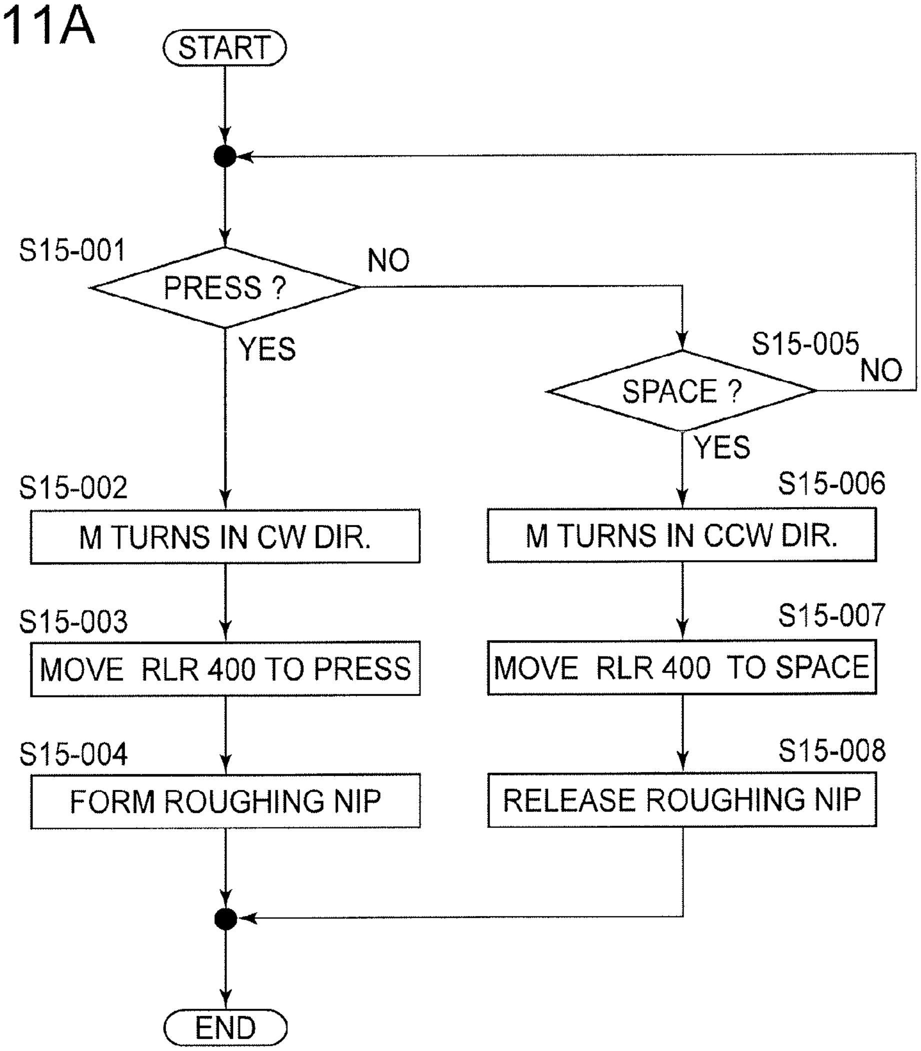


FIG. 11B

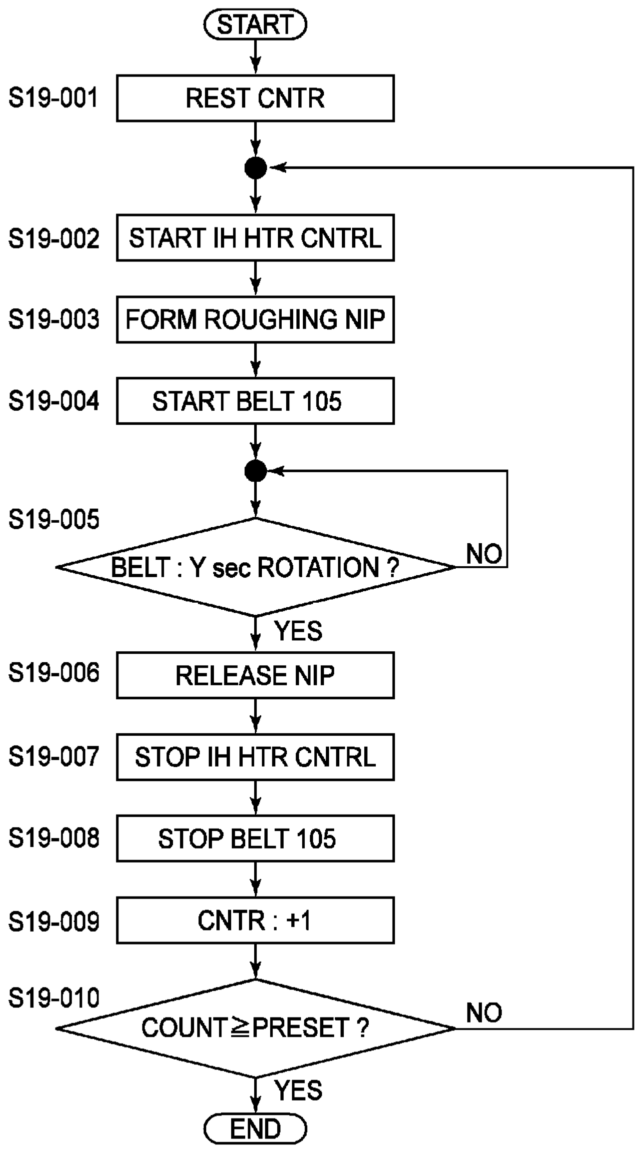

START
S19-001
REST CNTR
S19-002
START IH HTR CNTRL
S19-003
FORM ROUGHING NIP
S19-004
START BELT 105
S19-005
BELT : Y sec ROTATION ?
NO
YES
S19-006
RELEASE NIP
S19-007
STOP IH HTR CNTRL
S19-008
STOP BELT 105
S19-009
CNTR : +1
S19-010
COUNT≧PRESET ?
NO
YES
END

FIG.12

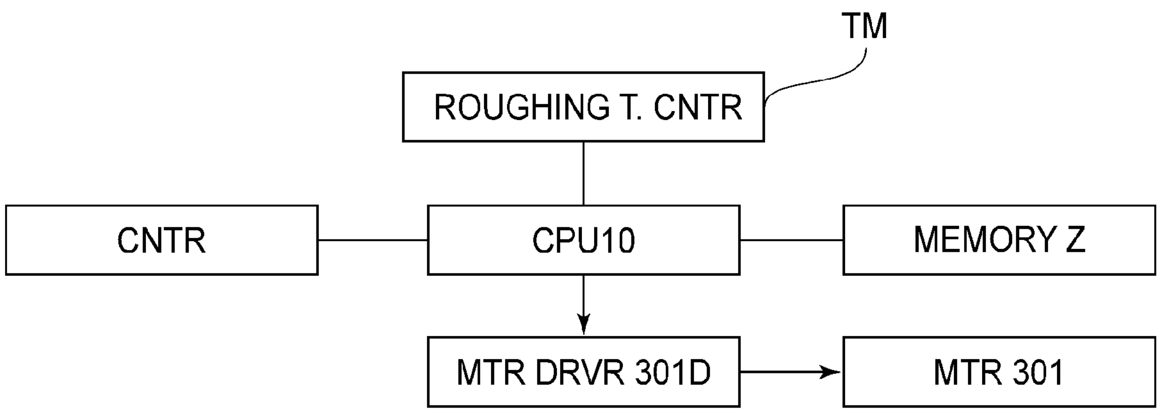


FIG.13

FIG. 14A

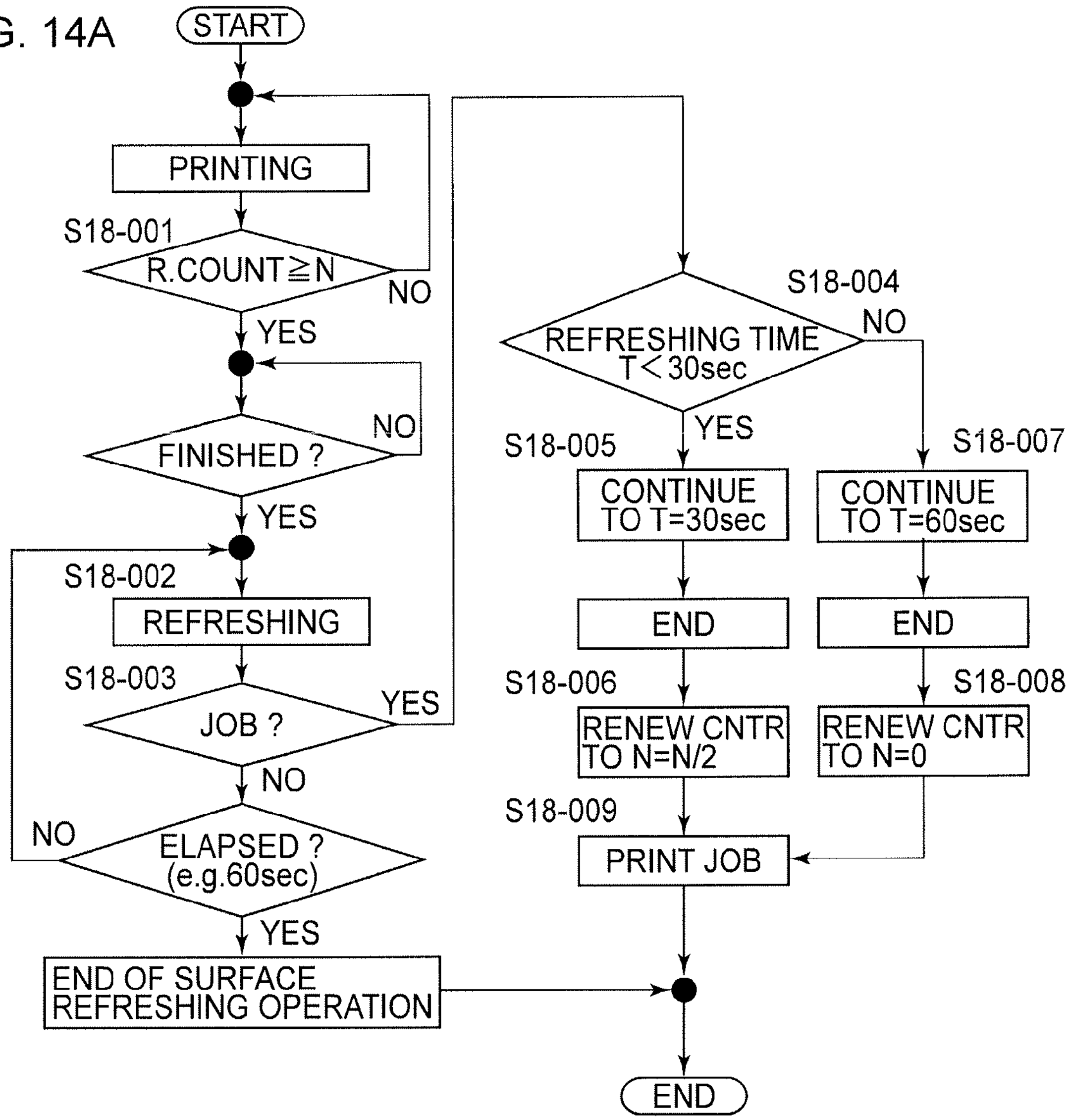
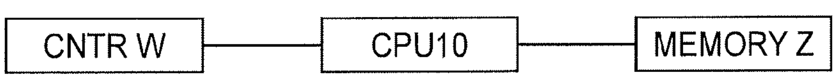


FIG. 14B



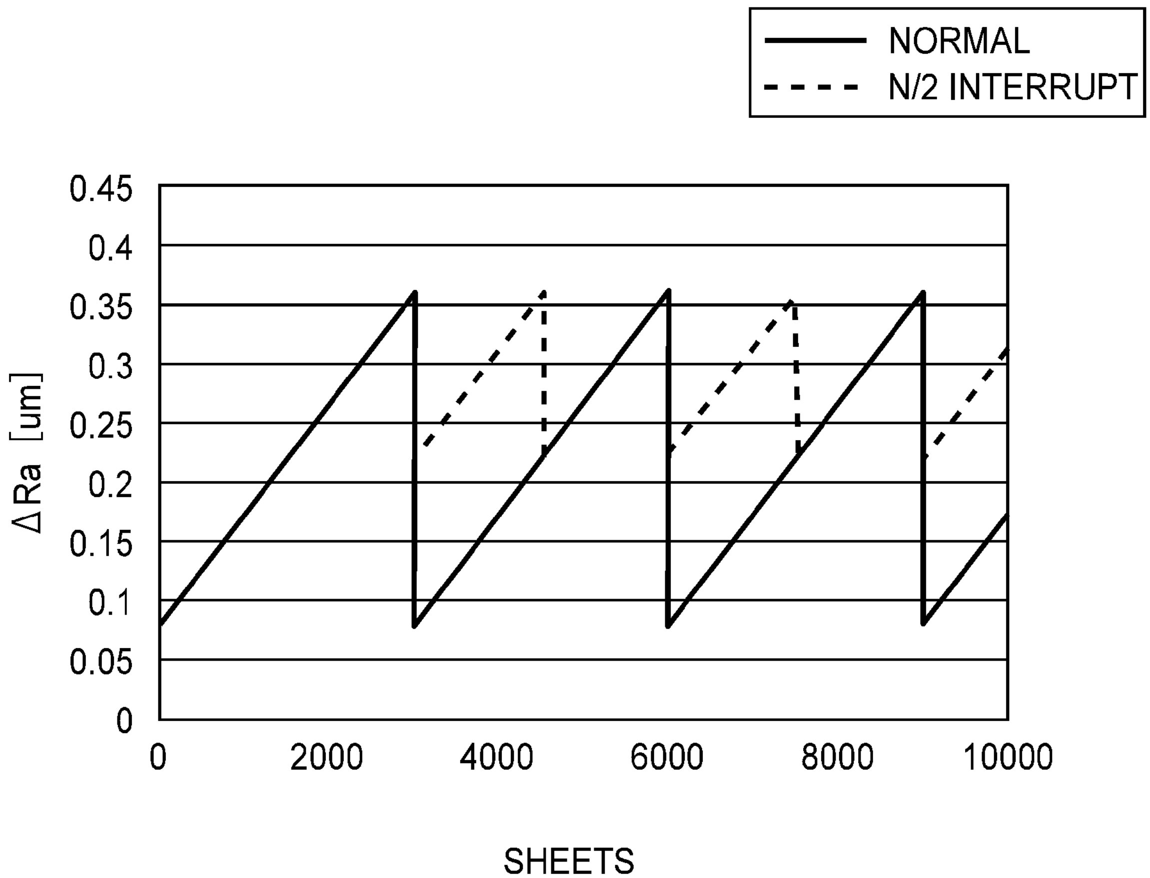

NORMAL
N/2 INTERRUPT
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
ΔRa [um]
0
2000
4000
6000
8000
10000
SHEETS

FIG.15

IMAGE HEATING APPARATUS

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to an image heating apparatus for heating a toner image on a sheet of a recording medium. An image heating apparatus can be used by various image forming apparatuses such as a copying machine, a printer, a facsimile machine, and a multifunction machine capable of performing two or more functions of the preceding examples of an image forming apparatus.

Generally speaking, image forming apparatuses which use an electrophotographic method are equipped with a fixing device which fixes a toner image formed on a sheet of a recording medium (paper), in the nip which is between the two fixing members (rotational members) of the fixing device. In recent years, toners which are higher in meltability have been ardently developed. The higher the toner in meltability, the more uniformly and more satisfactorily the toner can be melted by a fixing device, and therefore, the more uniform and flatter, and therefore the toner layer (toner image) becomes higher in gloss as it is fixed. Thus, by using toner that is higher in meltability, it is possible to form an image that is glossier and higher in image quality than an image formed with the use of the conventional toner, or toner which is lower in meltability, on a sheet of highly glossy paper, such as a sheet of coated paper.

However, as the cumulative length of time of usage of the fixing device structured as described above increases, the surface properties of the portions of its fixing members (lengthwise ends in terms of direction perpendicular to the recording medium conveyance direction), which correspond in position to the edges of a sheet of the recording medium, are likely to deteriorate. More concretely, the areas of the surface of the fixing member, which come into contact with the edges of a sheet of the recording medium, are likely to become rougher than the rest. As the surface properties of the fixing member become non-uniform as described above, the non-uniform surface texture of the fixing member is reflected by the toner image as the toner is fixed. That is, as the unfixed toner image is fixed, the toner image becomes non-uniform in gloss, which is problematic.

Thus, the fixing devices disclosed in Japanese Laid-open Patent Applications 2008-040363 and 2008-040364 are provided with a roughening roller (rubbing rotatable member) for abrading the surface of the fixing member. More concretely, a fixing member is abraded by the roughening roller to make the portions of the fixing member, whose surface properties have deteriorated (surface roughness) due to their repeated contact with the sheet edges, inconspicuous in surface texture, in comparison to the other portions of the surface of the fixing member.

However, in a case where the surface of the fixing member is roughened with the use of a roughening roller as described in Japanese Laid-open Patent Applications 2008-040363 and 2008-040364, it is desired that the surface of the fixing member is continuously roughened for a certain length of time (60 seconds, for example) in order for the roughening process to be effective.

In the case of an image forming apparatus equipped with a fixing device structured as the one described above, if a command to start an image forming job (command to start image heating process) is received by the apparatus while the surface of the fixing member is roughened, it starts the job after the completion of the on-going roughening process.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, there is provided an image heating apparatus comprising: first and second rotatable members cooperative with each other to form a nip therebetween for heating a toner image on a sheet; a rubbing rotatable member configured to rub an outer surface of the first rotatable member; a moving mechanism configured to move the rubbing rotatable member between a contact position in which it contacts the first rotatable member and a spacing position in which it is spaced from the first rotatable member; a measuring portion configured to measure the time elapsed from the start of a rubbing process executed with the rubbing rotatable member placed in the contact position; a controller for discriminating, upon receipt of execution instructions of the image heating process during the execution of the rubbing process, whether to continue the rubbing process or to interrupt the rubbing process and execute the image heating process, on the basis of the time measured by the measuring portion.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of the image forming apparatus in the first embodiment of the present invention, and is for illustrating the image forming apparatus.

FIG. **2** is an external perspective view of the fixing device in the first embodiment.

FIG. **3** is a cross-sectional view of the essential portion of the fixing device, as seen from the right side of the device (when bottom belt assembly B is under pressure).

FIG. **4** is a cross-sectional view of the essential portion of the fixing device as seen from the left side of the device (when bottom belt assembly is remaining separated from top belt assembly).

FIG. **5** is a cross-sectional view of the essential portion of the fixing device, as seen from the left side of the device (when bottom belt assembly B is under pressure).

FIG. **6** is a perspective view of the belt deviation control mechanism.

FIG. **7**A is a flowchart of the control sequence for vertically moving the bottom belt assembly, and FIG. **7**B is a block diagram of the control system.

FIG. **8**A is a flowchart of the fixation belt temperature control sequence, and FIG. **8**B is a block diagram of the control system.

FIG. **9**A is a flowchart of the fixing operation control sequence of the fixing device, and FIG. **9**B is a block diagram of the control system.

FIGS. **10**A and **10**B are drawings for illustrating the roughening mechanism (surface property restoration mechanism).

FIG. **11**A is a flowchart of the roughening mechanism control sequence, and FIG. **11**B is a block diagram of the control system.

FIG. **12** is a flowchart of the surface property restoration sequence.

FIG. **13** is a block diagram of the surface property restoration control system.

FIGS. **14**A and **14**B are flowcharts of the surface property restoration control sequence (roughening operation).

FIG. **15** is a graph for describing the effects of the surface property restoration sequence carried out with no interruption, and that with an interruption.

DESCRIPTION OF THE EMBODIMENTS

Embodiment 1

(1) Image Forming Apparatus

FIG. **1** is a schematic sectional view of the image forming apparatus **1** in this embodiment, at a vertical plane which is parallel to the direction V in which a sheet S of the recording medium is conveyed. It is for describing the structure of the apparatus **1**. This image forming apparatus **1** (which hereafter is referred to simply as a-printer) is an electrophotographic full-color printer which employs an intermediary transferring member. This printer **1** can form an image which is in accordance with image data (electrical information about image to be formed) inputted into the printer control section **10** (which hereafter is referred to as CPU) from an external host apparatus **23** which is connected to the CPU **10** through an interface **22**, on a sheet S, and outputs the sheet S as a print.

A CPU **10** is a controlling means which integrally controls the operation of the printer **1**. It exchanges various electrical information signals with the external host apparatus **23** and the control panel of **24** of the printer **1**. Further, it processes the electrical information signals inputted from various processing devices and sensors, command signals to be given to the various processing devices, and controls a preset initial sequence and a preset image formation sequence. The external host apparatus **23** is a personal computer, a network, an image reader, a facsimile machine, or the like, for example.

There are four (first to fourth) image formation sections (UY, UM, UC and UK), being aligned in tandem from left to right as shown in FIG. **1**, in the printer **1**. Each image formation section (UY, UM, UC and UK) is an electrophotographic image formation system. The four image formation sections (UY, UM, UC and UK) are the same in structure, although they are different in the color of the toner, as developer, stored in their developing device **5**.

More concretely, each image formation section (UY, UM, UC and UK) has an electrophotographic photosensitive member **2** (which hereafter is referred to as a drum), and processing devices, more specifically, a charge roller **3**, a laser scanner **4**, a developing device **5**, a primary transfer roller **6**, etc., which perform processes on the drum **2**.

The drum **2** in each image formation section (UY, UM, UC and UK) is rotationally driven at a preset speed in the counterclockwise direction indicated by an arrow mark. On the drum **2** of the first image formation section UY, a yellow toner image, which corresponds to the yellow color component of a full-color image to be formed, is formed. On the drum **2** of the second image formation section UM, a magenta (M) color toner image, which corresponds to the magenta color component of the image to be formed, is formed. On the drum **2** of the third image formation section UC, a cyan (C) color toner image, which corresponds to the cyan color component of the image to be formed, is formed. Further, on the drum **2** of the fourth image formation section UK, a black (K) toner image, which corresponds to the black color component of the image to be formed, is formed. The processes for forming a toner image on the drum **2** of each image formation section (UY, UM, UC and UK), and the principle based on which a toner image is formed on the drum **2** of each image formation section U, are well-known, and therefore, are not described here.

There is an intermediary transfer belt unit **7** on the bottom side of the combination of the four image formation sections (UY, UM, UC and UK). This unit **7** has an intermediary transfer belt **8**, as an intermediary transferring member, which is flexible and endless. The belt **8** is suspended and tensioned by three rollers, which are a driver roller **11**, a tension roller **12**, and an idler roller **13** (which opposes a secondary transfer roller). As the driver roller **11** is driven, the belt **8** is circularly moved in the clockwise direction indicated by an arrow mark at a speed which corresponds to the rotational speed of the drum **2**. Against the idler roller **13**, the secondary transfer roller **14** is kept pressed with the application of a preset amount of force, with the presence of the belt **8** between the two rollers **13** and **14**. The area of contact between the belt **8** and secondary transfer roller **14** is the secondary transfer nip.

The primary transfer roller **6** of each image formation section (UY, UM, UC and UK) is on the inward side of the loop which the belt **8** forms. It is kept pressed against the downwardly facing portion of the peripheral surface of the drum **2**, with the placement of the belt **8** between the drum **2** and roller **6**. The area of contact between the drum **2** of each image formation section (UY, UM, UC and UK) and the belt **8** is the primary transfer nip of the image formation section (UY, UM, UC and UK). To the primary transfer roller **6**, a preset primary transfer bias is applied with preset control timing.

The yellow (Y), magenta (M), cyan (C) and black (K) toner images formed on the drums **2** of the image formation sections (UY, UM, UC and UK), respectively, are sequentially transferred in layers (primary transfer) onto the outward surface of the belt **8** in the primary transfer nips while the belt **8** is circularly moved. Consequently, an unfixed full-color image is synthetically formed on the belt **8**, of the four monochromatic toner images, different in color, layered on the belt **8**. Then, the unfixed full-color toner image is conveyed to the secondary transfer nip.

Meanwhile, sheets S of the recording medium stored in the first or second cassette **15** or **16** are fed one by one into the main assembly of the printer **1**, by a sheet feeding-conveying mechanism, and are sent one by one to a pair of registration rollers **18** through a sheet conveyance passage **17**. The pair of registration rollers **18** catch each sheet S, and temporarily hold the sheet S to correct the sheet S in attitude if the sheet S is angled relative to the sheet conveyance direction. Then, they send the sheet S to the secondary transfer nip with such timing that the sheet S arrives at the secondary transfer nip at the same time as the full-color toner image on the belt **8**.

While the sheet S is conveyed, remaining pinched between the secondary transfer roller **14** and the belt **8**, through the secondary transfer nip, a preset secondary transfer bias is applied to the secondary transfer roller **14**. Thus, the full-color toner image on the belt **8** is transferred onto the sheet S as if it is peeled away from the belt **8**. As the sheet S comes out of the secondary transfer nip, it is separated from the surface of the belt **8**, and is guided into a fixing device **100** as an image heating device, through a recording medium conveyance passage **19**. Then, the sheet S is subjected to heat and pressure in the fixing device. Thus, the unfixed toner image on the sheet S becomes fixed as a solid image to the sheet S. Then, as the sheet S comes out of the fixing device **100**, it is conveyed further by a pair of discharged roller **20** to be discharged into a delivery tray **21**.

(2) Fixing Device **100**

FIG. **2** is an external perspective view of the fixing device **100** as an image heating device. FIG. **3** is a vertical cross-sectional view of the essential portion of the fixing device **100**, as seen from the right side of the device **100**. It shows the fixing device **100** when the bottom belt assembly B is under pressure. FIG. **4** is a vertical cross-sectional view of the essential portion of the fixing device **100** as seen from the right side when the bottom belt assembly is free of pressure. FIG. **5** is a left side view of the essential portion of the fixing device **100** when the bottom belt assembly B is under pressure. FIG. **6** is a perspective view of the belt deviation control mechanism.

Regarding the dimension of the fixing device **100** as well as the structural components of the fixing device **100**, the lengthwise direction means the direction (or measurement) perpendicular to the direction V in which a sheet S of the recording medium is conveyed through the sheet conveyance passage of the fixing device **100**, whereas the widthwise direction (dimension) means the direction (dimension) that is parallel to the direction V in which the sheet S is conveyed through the sheet conveyance passage of the fixing device **100**.

The front side of the fixing device **100** is the sheet entrance side of the fixing device **100**. The rear side of fixing device **100** is the sheet exit side of the fixing device **100**. The left and right sides of the fixing device **100** are the left and right sides of the fixing device **100** as seen from the front side. In this embodiment, the left side is the same as the front side, and the right side is the same as the rear side. The top and bottom sides are the top and bottom sides with reference to the gravity direction. The upstream and downstream directions are with reference to the direction V in which a sheet S of the recording medium is conveyed. Further, the width of a belt or a sheet is the measurement of the belt or sheet, in terms of the direction perpendicular to the sheet conveyance direction.

The fixing device **100** in this embodiment is an image heating device of the so-called belt-nip type. Further, it is of the so-called electromagnetic induction heating type (IH), and also, oil-less fixation type.

This fixing device **100** has: a top belt assembly A as a heating unit; the bottom belt assembly B as a pressure applying unit; and a bottom assembly moving mechanism (means for placing bottom belt assembly B in contact with, or separating bottom belt assembly B from, top belt assembly A). It has also: an IH heater **170** (magnetic flux generating means), which is a heating means for heating the fixation belt **105** of the top belt assembly A; a belt deviation control mechanism for controlling the lateral deviation of the fixation belt **105** in; a roughening mechanism (surface property restoration mechanism) for restoring the fixation belt **105** in surface properties; etc. Hereafter, these components are described one by one.

(2-1) Top Belt Assembly A and IH Heater **170**

The top belt assembly A is disposed between the left and right top plates of the frame of the fixing device **100**. This assembly A has the fixation belt **105** (endless belt), as a rotational fixing member (fixing member: first rotational fixing member), the outward surface layer of which is a release layer, which faces the image bearing surface of a sheet S of the recording medium. It has also: multiple belt suspending members, more specifically, a driver roller **131** (supporting roller); a steering roller **132**, which doubles as a tension roller; and a pad stay **137**.

The driver roller **131** is disposed between the left and right top plates **140**, and on the sheet outlet side of the fixing device **100**. More specifically, the left and right end portions of the driver roller shaft **131*a*** are rotatably supported by the left and right top plates **140**, with the placement of a pair of bearings between the shaft **131*a*** and two plates **140**, one for one.

On the outward side of each of the left and right top plates **140**, a steering roller support arm **154** is disposed, which extends from the driver roller **131** side toward the sheet entrance side. The right supporting arm **154** (unshown) is fixed to the right top plate **140** (unshown). Referring to FIG. **6**, the left support arm **154** is supported by the left end of the shaft **131*a*** of the driver roller **131**, with the placement of a bearing **154*a*** between the support arm **154** and shaft **131*a***, being enabled to pivot upward or downward about the shaft **131*a***. The unattached end of the left support arm **154** is provided with a pin **151**, which was pressed into the arm **154**. Further, the sheet entrance side of the outward surface of the left top plate **140** is provided with a shaft **160**, which was pressed into the plate **140**.

Further, the top belt assembly A is provided with a worm wheel **152** (helical gear) which is integral with a fork-shaped plate **161** having a U-shaped groove **161*a***, and which is pivotally supported by the shaft **160**. Further, the pin **151** of the left support arm **154** is engaged in the groove **161*a*** of the fork-shaped plate **161**. The top belt assembly A is also provided with a stepping motor **155**, which is attached to the top plate **140**. A worm gear **157** fixed to the rotational shaft of the motor **155** meshes with the worm wheel **152**.

As the stepping motor **155** is driven forward or in reverse, the fork-shaped plate **161** is pivotally moved upward or downward by the combination of worm gear **157** and worm wheel **152**. Thus, the left support arm **154** pivotally moves upward or downward about the shaft **131*a***.

The steering roller **132** is disposed between the left and right top plates **140**, and it is on the sheet entrance side of the fixing device **100**. Further, the left and right ends of the shaft **132*a*** are rotatably supported by the above-described left and right support arms **154**, with the placement of a pair of bearings **153**. Each bearing **153** is supported by the support arm **154** in such a manner that it is allowed to slide relative to the support arm **154** in the belt tension direction, and is under the force generated by a tension spring **156** in the direction to move the bearing **153** away from the driver roller **131**.

The pad stay **137** is a component formed of stainless steel (SUS), for example. It is disposed on the inward side of the loop (belt loop) which the fixation belt **105** forms. In terms of the recording medium conveyance direction, it is disposed between the driver roller **131** and the steering roller **132**, and is located next to the driver roller **131**. In terms of the lengthwise direction of the fixing device **100**, it is disposed between the left and right top plates **140**. More specifically, its left and right ends are fixed to the left and right top plates **140**, respectively, in such an attitude that its belt-backing surface faces downward.

The fixation belt **105** is suspended by the combination of the driver roller **131**, the steering roller **132**, and the pad stay **137**, in such a manner that it bridges between the adjacent two of the components **131**, **132**, and **137**. It is under a preset amount of tension generated by the force generated by a belt tension spring **156** (compression spring) in the direction to move the steering roller **132** away from the driver roller **131**. The preset amount of force generated by the belt tension spring **156** in this embodiment is 200 N. The inward surface of the fixation belt **105**, which corresponds to the bottom side of the belt loop, is in contact with the belt-backing surface (downwardly facing surface) of the pad stay **137**.

As for a belt to be used as the fixation belt **105**, it may be any belt as long as it can be made to electromagnetically generate heat, and is heat resistant. For example, the fixation belt **105** may be an endless belt consisting of: a magnetic metal layer, such as a metallic (nickel) layer, stainless steel layer, etc., which is 70 μm in thickness, 30 mm in width, and 200 mm in circumference; a silicon rubber layer coated on the outward surface of the metallic layer to a thickness of 300 μm, for example; and a surface layer (release layer) which is a piece of PFA tube fitted around the silicon rubber layer.

The driver roller **131** is made up of a metallic core, and an elastic layer molded around the metallic core. More specifically, the metallic core is a piece of solid stainless steel, for example, and 18 mm in diameter. The elastic layer is formed of heat resistant silicon rubber. In terms of the recording medium conveyance direction, the driver roller **131** is disposed on the sheet exit side of the nip formed by the combination of the fixation belt **105**, and the pressure roller **120** as the second rotational fixing member (which will be described layer). As the pressure roller **121**, which will be described layer, is pressed against the driver roller **131**, the elastic layer of the driver roller **131** is elastically deformed by a preset amount.

As for the shape of the nip, which is formed between the driver roller **131** and the pressure roller **121** with the presence of the fixation belt **105** between the two rollers **131** and **121**, it is roughly straight. However, from the standpoint of preventing a sheet S of the recording medium from buckling due to the non-uniformity of the nip, in terms of the lengthwise direction of the nip, in the recording medium conveyance speed, the shape of the driver roller **131** and the pressure roller **121** may be made different from those in this embodiment. For example, the two rollers **131** and **121** may be shaped so that in terms of the sectional view parallel to their axial line, their peripheral surface negatively crowns.

The steering roller **132** is a hollow roller. It is formed of stainless steel, for example, and is roughly 20 mm in external diameter, and 18 mm in internal diameter. The steering roller **132** functions as a tension roller, which provides the fixation belt **105** with tension. Moreover, it functions as a steering roller, whose angle is controlled by a belt deviation control mechanism, which will be described later, to prevent the fixation belt **105** from excessively deviating in its widthwise direction, that is, the direction perpendicular to the moving direction of the fixation belt **105**.

The driver roller **131** is fitted with a driving force input gear G. More specifically, the driving force input gear G is fixed to the left end of the shaft **131***a* of the driver roller **131**, in such a manner that the shaft **131***a* and the gear G become coaxial. To this gear G, the driving force is inputted from a driving motor **301** (FIG. **2**) through a driving force transmitting means (unshown), whereby the driver roller **131** is rotationally driven in the clockwise direction indicated by an arrow mark in FIG. **3** at a preset speed.

As the driver roller **131** is rotationally driven, the fixation belt **105** is circularly moved by the rotation of the driver roller **131** in the clockwise direction indicated by the arrow mark at a speed which corresponds to the speed of the driver roller **131**. As for the steering roller **132**, it is rotated by the circular movement of the belt **105**. The fixation belt **105** is made to move circularly, with the inward surface of the portion of the fixation belt **105**, which corresponds to the bottom side of the belt loop, sliding on the belt-backing surface, that is, the downwardly facing surface, of the pad stay **137**, in order to ensure that the driving force is reliably transmitted to the fixation belt **105** so that a sheet S of the recording medium is reliably conveyed through the fixation nip N, which will be described later.

The IH heater **170** as a heating means for heating the fixation belt **105** is a magnetic induction heating coil unit. It is made up of an excitation coil, a magnetic core, a holder for holding the coil and the core, etc. It is disposed on the top side of the top belt assembly A, in such a manner that a preset amount of a gap is provided between the IH heater **170** and the portion of the fixation belt **105**, which corresponds to the combination of the top portion of the belt loop and the steering roller **132**. It is disposed between the left and right top plates **140**, with its left and right ends fixed to the left and right top plates **140**, respectively.

As the excitation coil of the IH heater **170** is supplied with alternating electric current, it generates an alternating magnetic flux, which is guided to the magnetic metallic layer of the fixation belt **105**, which is an inductive heat generating member, by the magnetic core. Thus, an eddy current is induced in the magnetic metallic layer. This eddy current generates Joule's heat in the magnetic metallic layer, because of the presence of the specific electrical resistance of the inductive heat generating member. The alternating electric current to be supplied to the excitation coil is controlled by the CPU **10** based on the temperature information from a thermistor **220** for detecting the surface temperature of the fixation belt **105**, in such a manner that the surface temperature of the fixation belt **105** remains within a range of roughly 140-200° C. (target range).

(2-2) Bottom Belt Assembly Band Mechanism for Pressing Bottom Belt Assembly B Upon Top Belt Assembly A or Separating Bottom Belt Assembly B from Top Belt Assembly A

The bottom belt assembly B is disposed on the bottom side of the top belt assembly A. It is attached to the bottom frame **306** (pressure application frame) which is supported by the shaft **304** fixed to the sheet exit side of the left and right bottom plates **303** of the fixing device **100**, in such a manner that it is pivotally movable upward or downward about the shaft **304**.

This assembly B has the flexible pressure belt **120** (endless belt) as a rotational fixing member (pressure applying member: second rotational fixing member) which forms the nip between itself and the fixation belt **105** of the top belt assembly A. Further, it has the pressure roller **121** (pressure roller) and the tension roller **122**, as belt suspending members, by which the pressure belt **120** is suspended and kept tensioned, and the pressure pad **125**.

The left and right ends of the shaft **121***a* of the pressure roller **121** are disposed between the left and right lateral plates of the bottom frame **306**, and are rotatably supported by the left and right plates, with the placement of a pair of bearings **159** between the shaft **121***a* and left and right plates, one for one. The left and right ends of the shaft **122***a* of the tension roller **122** are rotatably supported by the left and right plates of the bottom frame **306**, with the placement of a pair of bearings **158** between the shaft **122***a* and the left and right plates, one for one. Each bearing **158** is supported by the bottom frame **306** in such a manner that it is allowed to slide on the bottom frame **306** in the belt tension direction, and is under the force generated by the belt tension spring **127** (compression spring) in the direction to move the bearing **158** away from the pressure roller **121**.

The pressure pad **125** is formed of a silicon rubber, for example. It is disposed between the left and right plates of the bottom frame **306**, and its left and right ends are fixed to the left and right plates of the bottom frame **306**, respectively, being thereby supported by the bottom frame **306**. The pressure roller **121** is disposed between the left and right plate of the bottom frame **306**. In terms of the recording medium conveyance direction, the pressure roller **121** is on the sheet exit side of the nip N. As for the tension roller **122**, it is disposed between the left and right plates of the bottom frame **306**, and is on the sheet entrance side of the fixing device **100**. The pressure pad **125** is non-rotationally disposed on the inward side of the pressure belt loop. It is between the pressure roller **121** and the tension roller **122**, being positioned next to the pressure roller **121**, with its belt supporting surface facing upward.

The pressure belt **120**, which is supported by the pressure roller **121**, the tension roller **122**, and the pressure pad **125** in such a manner that it bridges between the adjacent two components **121**, **122** and **125**. It is provided with a preset amount of tension by the tension roller **122**, which is under the force generated by a belt tension spring **127** (compression spring) in the direction to move the tension roller **122** away from the pressure roller **121**. In this embodiment, the preset amount of tension is 200 N. The pressure belt **120** is in contact with the upwardly facing surface of the pressure pad **125** by the inward surface of its top portion with reference to the loop which the pressure belt **120** forms.

A belt that is to be used as the pressure roller **121** may be any belt, as long as it is heat resistant. For example, it may be an endless belt comprising: a metallic (nickel, for example) layer which is 50 μm in thickness, 30 mm in width, and 200 mm in circumference; a silicon rubber layer coated on the peripheral surface of the metallic layer; and a surface layer, which is a piece of PFA tube fitted around the silicon rubber layer. The pressure roller **121** is a solid stainless roller, which is 20 mm in external diameter, for example. The tension roller **122** is a hollow roller which is formed of stainless steel, for example, and is roughly 20 mm in external diameter, and 18 mm in internal diameter.

The bottom belt assembly B is pivotally movable about the shaft **304** in the upward or downward direction by the bottom belt assembly moving mechanism as the means for placing the bottom assembly B in contact with the top belt assembly A or separating the bottom belt assembly B from the top belt assembly A. That is, the bottom belt assembly B is pivotally movable upward by the belt assembly moving mechanism into a pressure application position as shown in FIG. **3**, or downward into the noncontact position as shown in FIG. **4**.

As the bottom belt assembly B is moved to its pressure application position, the pressure roller **121** and the pressure pad **125** are pressed against the driver roller **131** and the pad stay **137**, respectively, of the top belt assembly A, by a preset amount of pressure, with the pressure belt **120** and the fixation belt **105** pinched between the combination of the pressure roller **121** and the pressure pad **125** and the combination of the driver roller **131** and the pad stay **137**. Thus, the fixation nip N, which has a preset width, in terms of the direction V in which a sheet S of the recording medium is conveyed, is formed between the fixation belt **105** of the top belt assembly A and the pressure belt **120** of the bottom belt assembly B. On the other hand, as the bottom belt assembly B is moved to its noncontact position, the pressure belt **120** is separated from the fixation belt **105**, and the preset amount of pressure applied to the top belt assembly A by the bottom belt assembly B is eliminated.

Next is described the above-mentioned mechanism for moving the bottom belt assembly B in this embodiment. The bottom frame **306** is provided with a compression spring unit which is on the opposite side of the bottom frame **306** from the shaft **304**. The compression spring unit is provided with a compression spring **305** for keeping the bottom belt assembly B elastically in contact with the top belt assembly A.

There is a pressure application cam shaft **307** between the bottom portions of the left and right plate **303**, being rotatably borne by a pair of bearings. To the left and right ends of this pressure application cam shaft **307**, a pair of eccentric pressure application cams **308**, which are for pressing the bottom frame **306** by the bottom surface, and which are the same in shape, are fixed so that they become the same in rotational phase. To the left end of the pressure application cam shaft **307**, a pressure application gear **30** (FIG. **2**) is coaxially fixed. To this gear **309**, a driving force is inputted from a pressure application motor **302** through a driving force transmitting means, whereby the pressure application cam shaft **307** is rotationally driven.

The rotation of the pressure application cam shaft **307** is controlled so that it is moved into the first angular position in which the largest radius portion of the cam **308** points upward as shown in FIGS. **3** and **5**, or the second angular position in which the largest radius portion of the cam **308** points downward as shown in FIG. **4**.

As the pressure application cam shaft **307** is moved into the first angular position, and stopped there, the bottom frame **306**, which holds the bottom belt assembly B, is lifted by the largest radius portion of the eccentric pressure application cam **308**. Thus, the bottom belt assembly B is placed in contact with the top belt assembly A while compressing the compression spring **305** of the pressure application spring unit. Thus, the bottom belt assembly B is elastically pressed upon the top belt assembly A by a preset amount of pressure (400 N, for example) generated by the resiliency of the compression spring **305**, and is held in the pressure application position shown in FIG. **3**.

Here, as the pressure roller **121** is pressed against the driver roller **131**, the driver roller **131** bends in the opposite direction from the pressure roller **121** by roughly several hundreds of microns. This bending of the fixation roller **101** is the primary cause of the problem that the center portion of the fixation nip N in terms of the lengthwise direction of the nip is weaker in internal pressure than the rest. In this embodiment, therefore, in order to prevent this problem, the driver roller **131**, or both the driver roller **131** and the pressure roller **121** are shaped so that in terms of their cross-sectional view, their peripheral surface bows outward to ensure that the nip, which the driver roller **131** and the pressure roller **121** form, becomes roughly straight. In this embodiment, the driver roller **131** is shaped so that its peripheral surface bows outward by 300 μm in terms of its cross sectional view.

On the other hand, as the pressure application cam shaft **307** is rotated into the second angular position, and is stopped there, the largest radius portion of the eccentric pressure application cam **308** points downward, and the smallest radius portion of the eccentric pressure application cam **308** points upward. Thus, the bottom belt assembly B is lowered by the resiliency of the compression spring **305**. That is, the bottom belt assembly B is moved away from the top belt assembly A, and is held in the noncontact position shown in FIG. **4**, being separated from the top belt assembly A in a preset manner.

Next, referring to the control flowchart in FIG. **7**A, and the block diagram of the control system in FIG. **7**B, the control sequence for moving the bottom belt assembly B upward or downward is described.

When the printer **1** is not in operation, the bottom belt assembly B is held in the noncontact position shown in FIG. **4**. As a pressure application command is issued by the CPU **10** <**S13-001**>, the pressure application motor **302** is rotated by the motor driver **302**D in the CW direction by a preset number N of times <**S13-002**>, whereby the pressure application cam shaft **307** is rotationally driven by half a turn. Thus, the angular position of the eccentric pressure application cam **308** is changed from the second angular position shown in FIG. **4** to the first angular position shown in FIGS. **3** and **5**, whereby the bottom belt assembly B is pivotally moved upward. Thus, the the pressure roller **121** and the pressure pad **125** are moved into their pressure application positions <S**134-003**>.

That is, the pressure roller **121** and the pressure pad **125** are pressed against the driver roller **131** and the pad stay **137** of the top belt assembly A, respectively, by the preset amount of pressure, with the presence of the pressure belt **120** and the fixation belt **105** being pinched between the combination of the pressure roller **121** and the pressure pad **125** and the combination of the driver roller **131** and the pad stay **137**. Thus, the fixation nip N having the preset width in terms of the sheet conveyance direction V is formed between the fixation belt **105** and the pressure belt **120**<S**13-004**>.

On the other hand, as a separation command is issued by the CPU **10** when the bottom belt assembly B is held in the pressure application position shown in FIG. **3**<S**13-005**>, the pressure application motor **302** is rotated a preset number N of times in the CCW direction by the motor driver **302**D <S**13-006**>. Thus, the pressure application cam shaft **307** is rotationally driven by half a turn, whereby the eccentric pressure application cam **308** is moved from the first angular position shown in FIGS. **3** and **5** to the second angular position shown in FIG. **4**. Thus, the bottom belt assembly B is pivotally moved downward, whereby the pressure roller **121** and the pressure pad **125** are moved into their separation positions <S**13-008**>. Thus, the fixation nip N vanishes <S**13-009**>.

(2-3) Fixing Operation and Temperature Control

Next, referring to the control flowchart in FIG. **9**A, and the block diagram of the control system in FIG. **9**B, the fixing operation of the fixing device **100** is described. When the fixing device **100** is kept on standby, the bottom belt assembly B is held in the noncontact position, and the driving motor **301** is kept stationary. Further, the IH heater **170** is not supplied with electric power.

The CPU **10** begins the preset image formation sequence in response to the inputting of a printing job start signal. Regarding the fixing device **100**, the CPU **10** drives the pressure application motor **302** with the use of the motor driver **302**D with a preset control timing to rotationally drive the pressure application cam shaft **307** by half a turn, thereby causing the bottom belt assembly B to move from the noncontact position shown in FIG. **4**, into the pressure application position shown in FIG. **3**. Thus, the fixation nip N is formed between the fixation belt **105** and pressure belt **120** <S**16-001**>.

Next, the CPU **10** instructs inputting of the driving force into the driving force input gear G by driving the driving motor **301** with the use of motor driver **302**D. Thus, the driver roller **131** of the top belt assembly A begins to be rotated, and therefore, the fixation belt **105** begins to circularly move.

Further, the rotational force of the driving force input gear G is transmitted to the pressure roller **121** of the bottom belt assembly B, through a driving force transmitting gear train (unshown). Thus, the pressure roller **121** is rotationally driven in the counterclockwise direction indicated by an arrow mark in FIG. **3**. As the pressure roller **121** rotates, the pressure belt **120** begins to be circularly moved in the counterclockwise direction indicated by an arrow mark by the friction between the pressure belt **120** and the fixation belt **105** <S**16-002**>. The direction in which the fixation belt **105** moves in the fixation nip N and the direction in which the pressure belt **120** moves in the fixation nip N are the same, and the speed at which the fixation belt **105** moves in the fixation nip N, and the speed at which the pressure belt **120** moves in the fixation nip N are roughly the same.

Next, the CPU **10** increases the temperature of the rotating fixation belt **105** to a preset level (target level), and maintains the temperature at the target level, by heating the fixation belt **105** by magnetic induction by supplying the IH heater **170** with electrical power with the use of the heater controller **170**C (FIG. **8**B) and the heater driver **170**D. More specifically, the CPU **10** begins the temperature control sequence which increases the temperature of the fixation belt **105** to the target level, which is in a range of 140 degrees to 200 degrees, and maintains it at the target level, according to the basis weight of a sheet S of the recording medium, paper type, etc., which is conveyed through the printer **1** (fixing device **100**) <**S16-003**>.

Then, as soon as the nip N is formed, the belts **105** and **120** begin to be circularly moved, and the temperature of the belt **105** is increased to, and begins to be maintained at, the target level, a sheet S of the recording medium having an unfixed toner image t (FIG. **3**) on its upwardly facing surface is guided into the fixing device **100**. More concretely, the sheet S enters the fixation nip N, that is, the area of contact between the fixation belt **105** and the pressure roller **121**, while being guided by the entrance guide **184** which is at the sheet entrance of the fixing device **100**. The entrance guide **184** is provided with a flag sensor **185** having a photo-interrupter, to detect the sheet conveyance timing.

The sheet S of the recording medium is conveyed through the fixation nip N, remaining pinched by the fixation belt **105** and the pressure belt **120**, in such an attitude that its image bearing surface faces the fixation belt **105**, and its opposite surface from the image bearing surface faces the pressure belt **120**. Thus, the unfixed toner image t on the sheet S is fixed as a permanent image to the sheet S by the heat from the fixation belt **105** and the nip pressure. After the sheet S is conveyed through the fixation nip N, it is separated from the surface of the fixation belt **105**, and comes out of the sheet exit side the fixing device **100**. Then, it is conveyed further, and discharged into the delivery tray **21**, by the pair of discharge rollers **20** (FIG. **1**).

As soon as the last sheet S of the recording medium in a printing job for outputting a single print, or multiple prints, is conveyed, the CPU **10** stops heating (fixation belt temperature control sequence), and stops supplying the IH heater **170** with electric power <**S16-004**>. Further, it stops the circular movement of the fixation belt **105** and the pressure belt **120** by turning off the driving motor **301**<**S16-005**>.

Further, the CPU **10** moves the bottom belt assembly B from the pressure application position shown in FIG. **3** to the noncontact position shown in FIG. **4** by rotationally driving the pressure application cam shaft **307** half a turn by driving the pressure application motor **302** with the use of the motor driver **302**D. Thus, the fixation nip N between the fixation belt **105** and the pressure belt **120** vanishes <S**16-006**>. Then, the CPU **10** waits for the inputting of the next print job start signal.

Next, referring to the control flowchart in FIG. **8**A, and the block diagram of the control system in FIG. **8**B, the temperature control of the fixation belt **105** is described. The top belt assembly A is equipped with the thermistor **220** as a temperature detecting member for detecting the surface temperature of the fixation belt **105**. The CPU **10** begins to supply the IH heater **170** with electric power through the heater controller **170**C and the heater driver **170**D, with a preset control timing, in response to the inputting of a print job start signal <**S17-001**>. Thus, the fixation belt **105** is increased in temperature by the heat which is electromagnetically induced in the fixation belt **105** by the IH heater **170**.

The temperature of the fixation belt **105** is detected by the thermistor **220**, and the detected temperature information (electrical information of temperature) is inputted into the

CPU **10**. If the temperature detected by the thermistor **220** is higher than a preset value (target temperature value), the CPU **10** stops supplying the IH heater **170** with electric power <**S17-003**>. Then, as the temperature detected by the thermistor **220** falls below the preset value <No in **S17-004**>, the CPU **10** begins to supply the IH heater **170** with electric power again <**S17-001**>.

By the repetition of the above-described steps <**S17-001**>-<**S17-004**>, the temperature of the fixation belt **105** is maintained at the preset target level (target temperature). The above-described fixation belt temperature control is continued until the printing job in which a single print, or multiple prints are to be outputted ends <**S17-005**>.

(2-4) Mechanism for Controlling Belt Deviation

The fixation belt **105** suffers from a phenomenon (lateral deviation of belt) that as it is circularly driven, it deviates in its widthwise direction, that is, the direction perpendicular to the sheet conveyance direction. As this phenomenon occurs, the pressure belt **120**, which forms the fixation nip N by being pressed upon the fixation belt **105**, also deviates along with the fixation belt **105**.

In this embodiment, the lateral deviation of the fixation belt **105** is controlled with the use of a belt deviation control of the so-called swing type, so that the lateral movement of the fixation belt **105** remains within a preset range. The belt deviation control of the swing type is such a controlling method that as it is detected that the fixation belt **105** has deviated from its central position, in terms of its widthwise direction, by a preset amount, the steering roller **132** is tilted in the opposite direction from the direction of the belt deviation. Repeating this belt deviation control causes the fixation belt **105** to periodically move back and forth in the widthwise direction in a preset range, and therefore, can stabilize the fixation belt **105** in its lateral movement. That is, the fixing device **100** is structured so that the fixation belt **105** is allowed to swing in the direction perpendicular to the direction V in which a sheet S of the recording medium is conveyed.

The top belt assembly A is provided with a sensor (unshown) which is disposed on the left (front) side of the fixation belt **105** to detect the position of the left edge of the fixation belt **105** relative to the steering roller **132**. The CPU **10** detects the position (belt deviation position) of the left edge of the fixation belt **105** with the use of this sensor, and rotates a stepping motor **155** in the positive (CW), or negative (CCW), direction, according to the detected position of the left edge of the fixation belt **105**, by a preset number of times.

Thus, the left steering roller support arm **154** is pivotally moved upward or downward about the shaft **131***a* by the combination of the above-described mechanisms **157**, **152**, **161** and **151** shown in FIGS. **5** and **6**, by a preset control amount. Thus, the angle of the steering roller **132** is changed, and therefore, the fixation belt **105** is controlled in its deviation.

(2-5) Mechanism for Roughening Fixation Belt **105**

Next, referring to FIGS. **10**A and **10**B, a roughening mechanism (surface property restoration mechanism) for restoring the surface properties of the fixation belt **105** is described. In this embodiment, the fixing device **100** is provided with a rotational abrading member (roughening member) for abrading the outward surface of the fixation belt **105** to restore the surface properties of the fixation belt **105**, which is located above the driver roller **131** of the top belt assembly A. As described above, this roughening roller is such a roller that is effective to restore the surface properties of the fixation belt **105** in a case where the portions of the outward surface of the fixation belt **105**, with which the lateral edges of a sheet S of the recording medium come into contact, become rougher in texture than the rest.

That is, the roughening roller **400** is such a roller that is used to roughly rub the entirety of the outward surface of the fixation belt **105**, in terms of the lengthwise direction, to make the portions of the outward surface of the fixation belt **105**, which have been made rougher in texture by the sheet edges, roughly the same in surface texture, as the portions of the outward surface of the fixation belt **105**, which have not been contacted by the sheet edges, in order to make inconspicuous the surface deterioration of the fixation belt **105**. In this embodiment, this process is referred to as "surface property restoration".

More concretely, as the surface texture of the above-described portions of the outward surface of the fixation belt **105** deteriorate to roughly 2.0 in surface roughness Rz, the outward surface of the fixation belt **105** are roughened (abraded) by the roughening (abrading) roller **400** to restore the outward surface of the fixation belt **105** in surface texture to 0.5-1.0 in surface roughness Rz. More specifically, in a case where the difference ΔRa in surface roughness Rz between the portions of the outward surface of the fixation belt **105**, which have come into contact with the edges of a sheet S of the recording medium, and the rest of the outward surface of the fixation belt **105**, becomes roughly 0.3, the outward surface of the fixation belt **105** is roughened (abraded) to reduce the difference ΔRa to roughly 0.1.

Although, in this member, the roller used in this embodiment to restore the fixation belt **105** in surface texture is referred to as "roughening roller **400**", the role of the roughening roller **400** is to keep the surface roughness of the outward surface of the fixation belt **105** satisfactorily low for a long time. Keeping the surface roughness of the outward surface of the fixation belt **105** satisfactorily low is closely related to the prevention of an image forming apparatus from outputting images which are non-uniform in gloss and unsatisfactorily low in gloss.

The roughening roller **400** is rotatably supported between the pair of left and right RF support arms **141**. More concretely, the pair of left and right RF support arms **141** are pivotally and coaxially supported by shaft **142**, which is fixed to the left and right top plates **140** of the frame of the fixing device **100**, and the roughening roller **400** is rotatably supported by the pair of left and right RF support arms **141** with the placement of a pair of bearings (unshown) between itself and the arms **141**.

The roughening roller **400** is made up of a metallic core, and abrasive particles which are densely adhered to the peripheral surface of the metallic core with the use of adhesive. The metallic core is formed of stainless steel, and is 12 mm in diameter. It is desired that abrasive is selected according to the target level of gloss for an image to be formed. That is, the abrasive is desired to be in a range of #1,000-#4,000 in particle size. Regarding the average particle diameter of the abrasive, particulate (grain size) abrasive that is #1,000 in particle size is roughly 16 μm in average particle diameter, and particulate abrasive that is #4,000 in particle size is roughly 3 μm in average particle size.

The particulate abrasive in this embodiment is based on alumina (called Alundum or Morundum). Alumina-based particulate abrasive is most widely used for industrial purposes. It is extremely hard compared to the surface of the fixation belt **105**, and is angular in particle shape, being therefore excellent in abrasiveness. In this embodiment, a particulate abrasive which is #2,000 in particle size (7 μm in average particle diameter) is used.

By the way, the roughening roller **400** in this embodiment was formed by densely adhering particulate abrasive to the metallic (stainless) core with the use of adhesive. However, this embodiment is not intended to limit the present invention in scope in terms of roughening roller selection. For example, the roughening roller **400** may be such a roller that is made by uniformly blasting the peripheral surface of the metallic (stainless) core to make the peripheral surface of the metallic core roughly 1.0-5.0, preferably, 2.0-4.0, in surface roughness.

(2-6) Mechanism for Placing Roughening Roller in Contact with, or Separating Roughening Roller from, Fixation Belt

The fixing device **100** in this embodiment is provided with a mechanism (moving mechanism) for placing the roughening roller **400** in contact with, or separating the roughening roller **400** from, the fixation belt **105**. Hereafter, this mechanism is concretely described. The fixing device **100** is structured so that when the printer **1** (fixing device **100**) is in the mode in which the fixation belt **105** is to be abraded, the lengthwise ends of the shaft of the roughening roller **400** are kept pressed toward the fixation belt **105** by a pressing mechanism. In this embodiment, the left and right RF support arms **141**, which will be described later, bear the role of this pressing mechanism.

There are disposed a pair of RF cams (eccentric cams) **407** on the top side of the left and right RF support arms **141**, one for one. The left and right RF cams **147** are the same in shape, and are fixed to the left and right ends of the RF cam shaft **408**, which is rotatably supported between and by the left and right top plates **140** of the frame of the fixing device **100**, with the placement of a pair of bearing between the RF cam shaft **408** and the left and right plates **140**, respectively, in such an attitude that the two cams **147** remain the same in rotational phase. Regarding the left and right RF support arms **141**, an RF separation spring **405** is disposed to be stretched between the opposite end of each of the left and right RF support arms **141** from the end by which the roughening roller **400** is supported, and an RF separation shaft **406** is fixed to the corresponding top plate **140**.

Thus, the left and right RF support arms **141** always remain under the force generated by the tension of the RF separation spring **405** in the direction to cause the corresponding RF support arm **141** to pivotally move about the shaft **142** in the direction to move the roughening roller **400** upward. Thus, the top surface of each of the left and right RF arm is made to remain in contact with the downwardly facing portion of the peripheral surface of the corresponding RF cam **407**, by the force generated by the tension of the RF separation spring **405**. Referring to FIG. **10**B, to the right end of the RF cam shaft **408**, an RF moving gear **409** is fixed. This RF moving gear **409** meshes mesh with the RF motor gear **411** of the RF motor **410**.

In this embodiment, when the surface properties of the fixation belt **105** do not need to be restored, the left and right RF cams **407** are kept stationary in their first attitude, in terms of their rotational phase, in which their largest radius portion points upward, as shown in FIGS. **3** and **4**. When the left and right RF cams **407** are in this state, the left and right RF support arms **141** are facing the smallest radius portion of the corresponding RF cam **407**. Therefore, the roughening roller **400** remains in the noncontact position, which keeps the roughening roller **400** separated from the fixation film **23** by a preset distance (FIGS. **3** and **4**). That is, the roughening roller **400** remains upwardly separated from the fixation belt **105** by the preset distance. Therefore, it does not act on the fixation belt **105**.

When it is necessary to restore the surface properties of the fixation belt **105**, the left and right RF cams **407**, which have been kept in the above-described first attitude, are rotated 180° into the second attitude in terms of rotational phase, in which their largest radius portion points downward as shown in FIG. **10**B, and then, are held in the second attitude. As the left and right RF cams **407** are rotated as described above, the left and right RF support arms **141** are pivotally moved downward about the shaft **142** by the corresponding RF cams **407** against the resiliency of the RF separation springs **405**. Thus, the roughening roller **400** is moved into, and held in, the pressure application position (contact position: FIG. **10**A) in which it forms a roughening nip R by being pressed upon the outward surface of the portion of the fixation belt **105**, which is in contact with the driver roller **131**, by a preset amount of pressure.

Further, an RF gear **403** fixed to one of the lengthwise ends of the roughening roller **400** meshes with the RF driving gear **401** fixed to the corresponding end of the driver roller **131**. Thus, the rotational force of the driver roller **131** is transmitted to the roughening roller **400** through the RF driving gear **401** and the RF gear **403**. Thus, the roughening roller **400** rotates in the opposite direction from the fixation belt **105**. That is, the roughening roller **400**, the surface layer of which is an abrasive layer, has a function of uniformly roughening (evening in surface texture) the outward surface of the fixation belt **105**, by rotating in the "width" direction (its peripheral surface moves in the same direction as fixation belt **105**), in the abovementioned roughening nip R, with the presence of a certain amount of difference in peripheral velocity between itself and the fixation belt **105**.

That is, the roughening roller **400**, which is a rubbing (abrading) member, is such a roller that rotates at a peripheral velocity that is different from the peripheral velocity of the fixation belt **105**. Regarding the switching of the position of the roughening roller **400** between the noncontact position and pressure application position, it is done by switching the attitude of the left and right RF support arms **141** between the first and second attitudes by rotating the RF motor gear **411**, the RF moving gear **409**, and the RF cam shaft **408** with the use of the RF pressing motor **410**. By the way, FIG. **10**A does not show the bottom belt unit B that forms the fixation nip N by being pressed upon the top belt unit A.

FIG. **11**A is a flowchart of the control sequence for the above-described roughening mechanism. When the fixing device **100** is not in the fixation belt roughening mode, the left and right RF cams **407** of the roughening mechanism are kept stationary in their first attitude, in terms of rotational phase, in which their largest radius portion points upward as shown in FIGS. **3** and **4**. That is, the roughening roller **400** is held in the noncontact position, in which it remains separated from the fixation belt **105** by a preset distance.

The CPU **10** issues a pressure application command with a preset pressure application control timing <**S15-001**: pressure application command>, to rotate the RF pressing motor **410** in the CW direction by a preset number M of times through the motor driver **410**D <**S15-002**>. Thus, the attitude of the left and right RF cams **407** are changed (position) from the first attitude (FIGS. **3** and **4**) to the second attitude (FIG. **10**A), whereby the roughening roller **400** is moved from the noncontact position (first position) to the pressure application position (second position <**S15-003**>. As the roughening roller **400** is moved into the pressure application position, it is pressed upon the fixation belt **105**, and therefore, the roughening nip R is formed between the roughening roller **400** and the fixation belt **105** <**S15-004**>.

The CPU **10** issues a separation command with a preset separation control timing <S**15-005**: separation command> to rotate the RF pressing motor **410** in the CCW direction by a preset number M of times with the use of the motor driver **410**D <S**15-006**>, whereby the attitude of the left and right RF cams **407** are switched (reversed) from the second attitude (FIG. **10**A) to the first attitude (FIGS. **3** and **4**), thereby causing the roughening roller **400** to be moved from the pressure application position to the noncontact position <S**15-007**>. As the roughening roller **400** is moved back into the noncontact position, the roughening nip N between the fixation belt **105** and the roughening roller **400** is made to vanish <S**15-008**>.

As described above, the roughening roller **400** is made to press on the outward surface of the fixation belt **105** to form the roughening nip N, and then, is rotated to restore the surface properties of the fixation belt **105**. Thus, it is possible that as the outward surface of the fixation belt **105** is roughened, minute particles are generated from the surface layer of the fixation belt **105** in the roughening nip N. As these minute particles collect in the roughening nip N, the effectiveness of the roughening roller **400** is gradually reduced the roughening (abrading) process is reduced in effectiveness.

In order to prevent the minute particles resulting from the roughening of the outward surface of the fixation belt **105**, from reducing the effectiveness of the roughening process, the fixing device **100** is configured so that during each roughening (abrading) sequence, the roughening roller **400** is made to shuttle twice or more times between the pressure application position and the noncontact position.

Next, referring to FIGS. **12** and **13**, this roughening (abrading) sequence is described. As the CPU **10** starts the roughening process (sequence), it resets a roughening operation counter CT to zero, and stores the value in the roughening operation counter CT, in a memory Z <S**19-001**>. Then, it begins to control the temperature of the fixation belt **105** with the use of the IH heater **170** to carry out the roughening process (abrading process) <S**19-002**>. This temperature control is based on FIGS. **8**A and **8**B.

As soon as the CPU **10** starts the temperature control, it forms the roughening nip N by causing the roughening roller **400** to press on the fixation belt **105** <S**19-003**>. Here, the formation of the fixation nip N is based on the sequence <S**15-001**>-<S**15-004**>. Then, it rotates the fixation belt **105** for a preset length Y of time (3 seconds in this embodiment) while measuring the length of time of the rotation with the use of a roughening time counter TM (FIG. **3**) <S**19-005**>.

As soon as the fixation belt **105** is rotated for Y seconds, the CPU **10** moves the roughening roller **400** to the noncontact position (five seconds in separation time) to cause the roughening nip R to vanish. Here, the roughening nip R vanishes following the sequence <S**15-005**>-<S**15-008**>.

Then, the CPU **10** adds one (+1) to the value stored in the roughening operation counter CT, and ends the first roughening operation <S**19-009**>. Here, the roughening sequence <S**19-002**>-<S**19-010**> is repeated until the value in the roughening operation counter CT reaches a preset value (six times in this embodiment).

The above-described process is the roughening (abrading) sequence (process). This roughening sequence (abrading sequence) can improve the efficiency with which the surface properties of the outward surface of the fixation belt **105** are restored. In this embodiment, the roughening sequence (abrading sequence), which includes the length of time necessary to cause the roughening roller **400** to press on the fixation belt **105**, and the length of time necessary to separate the roughening roller **400** from the fixation belt **105**, is controlled so that it ends in 60 seconds. Also in this embodiment, the combination of the above-described roughening operation counter CT, and the roughening timer TM makes up the timer for clocking the length of time having elapsed since the beginning of the abrading sequence, when the abrading process is carried out by moving the roughening roller **400** to the pressure application position.

FIGS. **14**A and **14**B illustrate the timing with which the operation for restoring the surface properties of the fixation belt **105** with the use of the roughening roller **400** is started. Referring to the block diagram in FIG. **14**A, in this embodiment, the CPU **10** counts the number of sheets S of the recording medium subjected to the fixation process (number of sheets subjected to image heating process) by the fixing device **100** in each printing job, with the use of a counter W (measuring section). Then, it cumulatively stores the sheet count in the memory Z.

Then, as the value (cumulative value: number of sheets S counted by counter W) reaches a preset number N (which in this embodiment is 3,000), the CPU **10** starts the operation (process for abrading the fixation belt with the use of a rotational abrading member) for restoring the surface properties of the fixation belt **105** with the use of the roughening roller **400**, after the on-going printing job ends, or by interrupting the on-going printing job. As soon as the surface property restoration operation ends, the CPU **10** resets the memory Z to zero; it changes the cumulative value in the memory Z to zero. In a case where the on-going printing job was interrupted, the printing job is restarted to finish the remaining portion of the job, after the operation for restoring the surface properties of the fixation belt **105** is carried out.

However, it takes 60 seconds to carry out the surface property restoration operation in its entirety, as described above. Thus, if a new printing job is thrown in while the surface property restoration operation is carried out, this job cannot be done until the surface property restoration operation ends. Thus, in order to minimize the length of the downtime attributable to the surface property restoration operation, the on-going surface property restoration operation is interrupted according to the length of time necessary to finish the unfinished portion of the on-going roughening process, in order to start the new printing job, and the value (cumulative value) stored in the memory Z is reduced by a value proportional to the remaining portion of the interrupted surface property restoration operation.

FIG. **14**A is a flowchart for illustrating the above-described surface property restoration operation. As the cumulative number of sheets S conveyed through the fixing device **100** becomes greater than a preset number N <S**18-001**>, the CPU **10** starts the surface property restoration operation after the on-going printing job ends <S**18-002**>.

In a case where a printing job is thrown in while the surface property restoration operation is carried out <S**18-003**>, the CPU **10** decides whether the surface property restoration operation is to be continued or interrupted, with reference to the remaining length T of time of the on-going surface property restoration operation, at the moment when the printing job was thrown in <S**18-004**>.

If the remaining length T of time is no more than 30 seconds, the CPU **10** continues the surface property restoration operation until T becomes 30<S**18-004**>.

If the remaining time T is no less than 30 seconds, the CPU **10** continues the surface property restoration operation for 60 seconds (T=60) <S**18-007**>, and resets the cumulative value in the counter to zero <S**18-008**>. As the surface property restoration operation ends, the CPU **10** puts the printer **1** on standby to wait for the next printing job <S**18-009**>.

The control sequences shown in FIGS. **12** and **14** can be summarized as follows.

1) The printer **1** has the timers CT and TM for measuring the length of time which elapses after the roughening roller **400** is moved to the pressure application position (contact position) to carry out the abrading process; the CPU **10** (control section) which determines, based on the length of time the abrading process was carried out, which was measured with the use of the measuring sections (timers) CT and TM, whether the abrading process is to be continued, or interrupted to carry out the fixing process. The above-described command for making the printer **1** (fixing device **100**) carry out a fixing process is issued as the CPU **10** receives a new printing job.

Regarding the above-described control, the printer **1** (fixing device **100**) may be structured so that instead of using the length of time the abrading process was carried out, the length of time the abrading process has to be carried out to complete the on-going abrading may be used as the reference.

2) If the length of time measured by the measuring sections CT and TM after the abrading process began to be carried out is longer than a preset value, the CPU **10** continues the on-going abrading process. On the other hand, if it is no more than the preset value, the CPU **10** interrupts the on-going abrading process, and makes the fixing device **100** carry out the fixation process.

3) The printer **1** has a measuring section (counter) W for counting the number of sheets S subjected to a fixing process, and if the number of sheets S counted by the measuring section W is no less than a preset value, the CPU **10** makes the printer **1** (fixing device **100**) carry out the abrading process while the fixation process is not being carried out.

4) If the length of time measured by the measuring sections CT and TM after the starting of the abrading process is no less than a preset value, the CPU **10** resets the value in the measuring section W to zero as soon as the abrading process is completed. On the other hand, if the length of time measured by the measuring sections CT and TM after the starting of the abrading process is no more than a preset value, the CPU **10** interrupts the on-going abrading process, and makes the fixing device **100** carry out the fixation process. Further, it reduces the value in the measuring section W.

5) When the fixing process needs to be carried out, the moving mechanism moves the roughening roller **400** into the noncontact position.

6) The printer **1** has the counter W for counting the number of sheets which were subjected to the fixing operation by the combination of the fixation belt **105** and the pressure belt **120**. It has also the CPU **10** (executing section) which makes the fixing device **100** to carry out the abrading process by moving the roughening roller **400** into the pressure application position (contact position) when the number of sheets S counted by the counter W is no less than a preset value, and the fixing process is not carried out.

If the CPU **10** receives a fixing process start command while the abrading process is carried out, and the relationship among the length of time Ts the on-going abrading process has been carried out, the total length T of time necessary to carrying out the on-going abrading process in its entirety, and a preset length Tc of time is: $T-Ts \geq Tc$, the CPU **10** continues the on-going abrading process until it is completed. On the other hand, if it is: $T-Ts<Tc$, the CPU **10** interrupts the on-going abrading process, and controls the fixing device **100** so that the fixing device **100** carries out the fixation process, and reduces the value in the counter W.

That is, the CPU **10** interrupts the refresh operation (on-going abrading process) according to the length of time which is remaining to be spent to complete the on-going abrading process when a new printing job is thrown in. Then, it starts the new print job, and reduces the refresh count value according to the remaining length of time. Thus, it is possible to reduce the length of the downtime attributable to the roughening operation, and also, to obtain satisfactory roughening effects.

The comparison, in terms of the effects of the roughening process upon the restoration of the surface properties of the fixation belt **105**, between a case in which a job is thrown in 30 seconds after a surface property restoration operation is started, and therefore, the surface property restoration operation was interrupted, and a case in which the surface property restoration operation is continued without interruption, is shown in FIG. **15**. Here, in FIG. **15**, the horizontal axis represents the number of conveyed sheets, and vertical axis represents the amount ΔRa of difference, in terms of the surface roughness Ra, between the portions of the fixation belt **105**, which came into contact with the edges of the sheets S, and the rest of the fixation belt **105**. This means that the smaller in value the amount ΔRa, the better the surface property restoration. It is evident from FIG. **15** that even in the case where the surface property restoration operation was interrupted 30 seconds after it was started, the value of ΔRa was kept roughly the same as in the case where the surface property restoration operation was not interrupted.

By the way, this embodiment was described with reference to a case where the operation for restoring the surface properties of the fixation belt **105** with the use of the roughening roller **400** is started after a preset number of sheets S of the recording medium were conveyed through the fixing device **100**, for fixation. However, this embodiment is not intended to limit the present invention in scope. That is, the operation for restoring the surface properties of the fixation belt **105** may be started according to the count of specific sheets. Further, it may be carried out before a printing job which is different in sheet size from the immediately preceding printing job is started. Moreover, it may be started by an instruction inputted by a user with a proper timing while the printer **1** is kept on standby for the next printing job.

Further, this embodiment was described with reference to the remaining length of time for the surface property restoration operation. However, this embodiment is not intended to limit the present invention in terms of the variables based on which the surface property restoration operation is started. For example, the surface property restoration operation may be started based on the length of time the surface property restoration operation was being carried out.

In the foregoing, one of the preferred embodiments of the present invention was described. However, the present invention can be embodied in the form of various fixing devices (image forming apparatuses) which are different in structure from the fixing device **100** (printer **1**) in the preceding embodiment. In the preceding embodiment, it was the fixation belt **105** that was abraded by the roughening roller **400**. However, the embodiment is not intended to limit the present invention in scope. For example, the present invention is also applicable to a case where the pressure belt **120** is abraded by the roughening roller **400**. The effects of the application are similar to those described with reference to the fixation belt **105**. This application is particularly effective when an image is formed on both surfaces of a sheet S of the recording medium.

That is, the present invention is applicable to a fixing device structured so that the first rotational member faces the surface, on which a toner image to be fixed is borne, or the opposite surface from the surface on which a toner image to be fixed is borne.

Further, in the above-described embodiment, the fixing device employed the fixation belt **105** and the pressure belt **120**. However, the application of the present invention is not limited to the fixing device **100** in the preceding embodiment. It is also similarly applicable to a fixing device which employs a fixation roller in place of the fixation belt **105**, or a fixing device which employs a pressure roller, or a rotational pad which is low in coefficient of friction, in place of the pressure belt **120**.

Further, in the above-described embodiment, the fixing device was for fixing an unfixed toner image t to a sheet S of the recording medium. However, the application of the present invention is not limited to a fixing device for fixing an unfixed toner image t to a sheet of the recording medium. For example, the present invention is also applicable to an apparatus (which also will be referred to as fixing device) for applying heat and pressure to a toner image which has been temporarily fixed to a sheet of the recording medium, in order to improve the toner image in gloss. The effects of the application are similar to those described above.

Further, in the above-described embodiment, the heating section used a heating method based on electromagnetic induction. However, the application of the present invention is not limited to a fixing device, the heating section of which uses a heating method based on electromagnetic induction. That is, the present invention is also applicable to a fixing device which employs a heating section which uses a heating method other than electromagnetic induction. For example, the present invention is also applicable to a fixing device, the heating section of which employs a halogen heater or the like. More concretely, the present invention is also similarly applicable to a fixing device, the driver roller **131** and/or the pressure roller **121** of which has an internal heating section made up of a halogen heater or the like.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2014-075363 filed on Apr. 1, 2014, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. An image heating apparatus comprising:

first and second rotatable members cooperative with each other to form a nip therebetween for heating a toner image on a sheet;

a rubbing rotatable member configured to rub an outer surface of said first rotatable member;

a moving mechanism configured to move said rubbing rotatable member between a contact position in which said rubbing rotatable member contacts said first rotatable member and a spacing position in which said rubbing rotatable member is spaced from said first rotatable member;

a measuring portion configured to measure the time elapsed from the start of a rubbing process executed with said rubbing rotatable member placed in the contact position; and

a controller configured to determine, upon receipt of an execution instruction of an image heating process during the execution of the rubbing process, whether to continue the rubbing process or to interrupt the rubbing process and execute the image heating process, on the basis of the time measured by said measuring portion.

2. An apparatus according to claim **1**, wherein said controller continues the rubbing process in the case that the measured time is not less than a predetermined time, and interrupts the rubbing process and executes the image heating process when the measured time is less than the predetermined time.

3. An apparatus according to claim **1**, further comprising a counter configured to count the number of the sheets subjected to the image heating process, wherein said controller executes the rubbing process in a non-image heating process period in accordance with the number of the sheets counted by said counter.

4. An apparatus according to claim **3**, further comprising a heating portion configured to heat said first rotatable member when said image heating process is executed, and wherein the rubbing process is executed in a state that first rotatable member is heated by said heating portion.

5. An apparatus according to claim **1**, wherein said moving mechanism places said rubbing rotatable member in the spacing position when the image heating process is executed.

6. An apparatus according to claim **1**, wherein said rubbing rotatable member includes #1000-#4000 abrasive grain at the surface thereof.

7. An apparatus according to claim **1**, wherein said rubbing rotatable member has a surface roughness Ra of 1.0-5.0.

8. An apparatus according to claim **1**, wherein by the rubbing process of said rubbing rotatable member, the surface roughness Rz of said first rotatable member becomes 0.5-1.0.

9. An apparatus according to claim **1**, wherein said first rotatable member includes an endless belt rotatably supported by a supporting roller at an inner surface, and said moving mechanism moves said rubbing rotatable member to the contact position such that said endless belt is sandwiched between said rubbing rotatable member and said supporting roller.

10. An apparatus according to claim **1**, wherein said first rotatable member is provided to contact a toner image carrying surface of the sheet.

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